EFFECT OF HOME AND SCHOOL ENVIRONMENTS ON SCIENTIFIC CREATIVITY

Effect of Home and School Environments on Scientific Creativity

KARUNA SHANKAR MISRA
M. Sc., M. Ed. Ph. D.
Reader, Department of Education,
University of Allahabad

SANGYANALAYA
Kanpur

The report has been published with support of a grant vide no. 21-7/85—Prog /360 from Educational Research and Innovations Committee, NCERT, New Delhi—16

Published by Sangyanalaya, Kanpur

and *Printed at* Academy Press, Allahabad

This book is dedicated
to the memory of my father,
Shri Pratap Narain Misra.

FOREWORD

We are living in an age of extremely rapid change. The children, studying in our schools today, will be full adults when our world enters into the twenty first century. Our present century has already developed computerized devices to store and disseminate information in the minutest detail and updated to the passing moment which no human brain, whatever be its power of memorization. can do. Thus the storehouse function of human brain will become defunct in the twenty first century, but some new kinds of brain power will have to be developed to cope with the fast changing knowledge. Creativity is one such power, that the next century will require the human beings to develop not only for controlling the nature with the help of scientific and technological power but to maintain human society and lead it to some higher plane than intellect could do Human society has reached the highest plateu of intellectual development and if a higher goal is not conceived, it will face disasterous vacuum. Creativity is ever new, it never ends ; its nature is every rising higher and higher , there is no finality in creativity. That which has been attained, is not creative ; creativity seeks for still newer and more uncommon heights which are yet to be attained.

Creativity is a unique mental power that expresses itself through different media. Scientists, technologists, artists and poets (and even house-wives) are endowed with this power which may remain dormant in the absence of proper stimuli The social environment may be conducive to or obstructive in the development of creative powers. Indian society, particularly composed of upper castes, is not permissive The fair sex suffers from a number of taboos and social restrictions in the home and outside. With the expansion of education, the situation is fast changing but it has led to greater diversity rather than uniformity in the social environment. We can observe two extremes in the permissiveness—nonpermissiveness continuum

Dr. K. S Misra has probed into the social phenomena with particular reference to home and school environments influencing the develop-

ment of scientific creativity among adolescent boys and girls. His task was strenuous but he performed it with full dedication, sincerity and professional integrity. The present book, which is based on his doctoral thesis, will be a valuable contribution to the existing knowledge on creativity and may also prove a guide to teachers and parents, who are keen to develop creativity among growing adolescents Dr. Misra has identified factors in the home and school environments that contribute positively to the development of creativity and also those factors that adversely affect the growth of creativity

The tools developed by Dr Misra are the by-products of his research but they are valuable for guidance workers He left no stone unturned to make the tools perfectly reliable and valid for purposes of research and guidance.

I am sure the book will be widely read used and by all interested in the future of human society

UDAIPUR

February 17, 1986

L K OAD

M A MED, PH. D (LONDON)

Former Dean, Faculty of Education,
Rajasthan University, Jaipur
and Ex-Dean of Education,
Banasthali Vidyapith, Rajasthan.

PREFACE

It is heartening to see Indians contributing significantly in the field of science Still, our attitudes toward the development of scientific creativity among students forecast a tenebrous future However, there is the case for resurrection of our hopes Our science education can be edified and cognitive materials can be prepared to ensure the speedy development of scientific creativity among children Existing child-rearing practices of parents and teachers' interaction with students can be edulcorated. Students with scientific creativity can be recognized and deemed to be acceptable in schools as well as homes Children can be helped to preserve their scientific creativity and strive for the development of it Parents and teachers can refrain from their acts of stamping out scientific creativity when its possessor is not gentle, orderly and unprovoking to a well-ordered home or classroom They can play the role of 'creative bloomers' but their success in accomplishing this task is contingent upon their understanding of the nature of home as well as school environment that can maximize rather than minimize or subvert students' scientific creativity The book attempts to help parents and teachers in the resurrection of their hopes It is based on author's doctoral dissertation accepted for the award of Ph D. degree in Education by University of Rajasthan, Jaipur

The original voluminous report has been edited. Some minor changes have been made in the original work in order to make it more concise, readable and updated Its antiquity has been carefully maintained The research work was conducted at College of Education, Banasthali Vidyapith under the guidance of Prof L K Oad The author fails to find apt words to express his indebtedness to him. His constructive criticism, fertile imagination, elucidations, genial smiles, discriminating taste in educational research, paternal temperament and affection have enabled me to carry out the research work and present it in book form.

The author expresses his gratitude to Prof R. K. Singh, Prof. R S. Trivedi, Prof R P. Bhatnagar, Prof S. K Pal, Prof R S Pandey, Prof.

B. K Passi and Prof. M. K. Raina for their compendious and erudite suggestions and morale boosting expressions that made the presentation of the book a reality The author also acknowledges the intellectual assistance provided by Dr. Santokh Singh, Dr Ipe, Dr J.P Srivastava, Dr S C, Soti, his teachers and researcher friends He is grateful to scholars whose research articles and books made it possible to view the research problem in proper perpective and integrate the findings of the present work to the existing knowledge The author is also thankful to the authorities of NCERT for sanctioning the publication grant.

It is hoped that the readers of the book will develop insight into the dynamics of scientific creativity Their awareness of the determinants of creative thinking in science will grow and they will be able to contribute to the development of the asset potentiality. It is expected to assist students and researchers planning to widen the horizons of current knowledge about the nature and nurture of creativity in various areas.

March, 1986

K S MISRA

CONTENTS

Creativity, Environment and Science Education

Creativity is not a characteristic of a selected few but a process that is within every one. It is essential for adaptation to life's demands and represents man's most pervading hope for going on. Creative insights are an essential part of survival process and creativity may hold the key to the stability and prosperity of future society(Petroska, 1983). It is the human quality of imagination for extraordinary effort that brings new and significant things into existence. These contributions are of many kinds ; ideas, devices, systems and organizations. It is this creative problem-solving process through which mankind has taken available energy, materials and information from the environment and transformed them in specific ways to improve efficiency and effectiveness in attaining goals (Mettal, 1977). Ours is a developing country and we need men of creativity who can think up solutions to the varied problems baffling the country. Her citizen's brains constitute her greatest asset because from their creative intellect will come future scientific discoveries, future works of art and literature, future advances in statesmanship, technology and social organization, in short all future progress. Her culture is to be saved from being collapsed because of her failure to utilize intelligent and imaginative methods for solving various pressing problems. We must remember that to give a fair chance to potential creativity is a matter of life and death for any society. If society fails to make the most of this human asset, or if worse still, it perversely sets itself to stifle it, man is throwing away his birth right of being the lord of creation and is condemning himself to be instead the least effective species on the face of this planet (Toynbee, 1964). Unless man can make new and original adaptations to his environment as rapidly as science can change the environment, our culture will perish (Rogers, 1961). Burrows and Wolf (1983) argue that creativity gives children

with specific language disabilities a sense of satisfaction and lessens a sense of frustration. Bedrosian and Jackson (1958) have aptly remarked, "What we should strive for are inventiveness and creativity, a shift in emphasis from 'acquiring' to 'inquiring' To say that students may attain these objectives by memorising and absorbing assorted bits of information is to provide no answer at all. If we wish to educate individuals to think creatively, for and by themselves, intellectual conformity must be eliminated as an education end-product" Since there can be no argument over this proposition, the practical problem becomes one of devising the best means of nurturing the talent which exists in the population (Wolf, 1954). Now a question strikes our mind Are we doing justice to the creative individuals in general and scientifically creative individuals in particular ?

1.1. The Plight of the Creative Child

The creative child is a divergent thinker He discovers or offers uncommon thoughts or ideas, unexpected suggestions and uncoventional views He is often engaged in play with ideas, finding other ways of doing things than those that are in the texts or the manuals or the teachers' guides His ways are not those of his classmates, brothers or sisters. Usually he is not of the group and he encounters resentment, ostracism, and hostility. As if this were not enough, the creative child in his school years is seen as leaning toward the feminine, if a boy, and toward the masculine, if a girl The felt necessity to conform to sex roles tends also to restrain creative development of some children He may enter into conflict with his parents or members of the community. "Why can't you be like all the others ?" is a common complaint of parents whose child is determined to follow his own processes of thought, his own means of expression, and his own ideals of attainment This is not to deny that a few creative parents may perceive their creative child as he really is and take joy in their knowledge, offering support, enrichment and occasional sympathy as the needs may demand. The creative child may go unrecognised or he may be unacceptable in the community within and outside the school Such a child will be on his way to vestigial creativity His unused power becomes flaccid, suppressed and ultimately like the vermiform appendix or the caudal vertebrae it is probably there but of no apparent use. Every one of us is trying to stamp out creativity unless its possesser is gentle, orderly, and unprovoking to a well-ordered classroom or family and teacher or parents. We seem to be deaf to Kravetz's (1970) remarks that—the creative child may experience conflict as he moves through his school years, clashing sporadically with his peers, with his teachers,

with the school administration, and may receive little support from parents. This storm and drag may teach the young scholar, inventor or artist to suppress his uniqueness and to "get on the team " He may then learn how to blend with his social environment and how to go along He may, being bright enough and desiring to be successful, give up his creativity for good, or postpone it. Such is the plight of a creative child in the surroundings The same may be the case with a child who thinks creatively in science. No one loves a loner and the curious discoverer in science is sure to face these adverse circumstances which cause emotional blocks in creative expression Most of them are on the road to personal and social disaster They have to withstand the pressures of success-failure, of right--wrong, of conforming to teachers', parents', elders' definitions and set formulae which bring death to scientific creativity Their creative behaviours are either ignored or negatively reinforced The situation is grave and its graveness worsens when we think of our education system

1 2 The Creative Child and Science Education

All of us agree that children should have the opportunity to explore materials on their own, to raise questions as they see them, to seek explanations which are reasonable to them, and to test their hypotheses and understanding through observation and experimentation No one appears to question the child's need to do some exploring on his own and to cope with problems if he is to learn in the spirit of science However, science has been and is being taught in most of our institutions as a body of discrete facts usually learned by rote Knowing many facts about science is not the same thing as understanding science which is a prerequisite for creative thinking in science Science has to do with making sense out of a number of facts, to find how they may be arranged to provide a meaningful explanation of an event, or codified to provide a more powerful idea Discrete facts in science are like the isolated notes in music They are without meaning except in combinations (Hurd, 1970) Facts that have been intellectually organized in terms of a concept, idea, model, hypothesis, law, or theory become data when focused upon a relevant problem or set of questions demanding undiscovered solution or answers This indicates that science teaching and creativity should go hand in hand. Lipathay, Held and Hinciar (1983) discussed the problem of Chemistry students who do not know how to creatively utilize the knowledge they have gained. These students were not able to overcome an overreliance on wellknown procedures and methods of work They suggested that students should be tutored in the creative application of their knowledge at the same time when they are taught a particular subject.

Unfortunately, our science education is examination-ridden and the examinations are simply a way of rating our student population in terms of ability to memorise and reproduce information. There exists great premium on conformity and uniformity rather than on scientific creativity Though creative learning of science is superior to learning by authority, we seldom allow science students to saturate themselves with knowledge, question, enquire, explore, experiment, manipulate or toy with scientific ideas, concepts, tools, symbols and materials Pupils, usually, have rare opportunities to call into play the abilities such as "fluency" the ability to think up numerous solutions, "flexibility" the ability to think different approaches or strategies; "originality"-the ability to think up unusual solutions and 'inquisitiveness"-the ability to ask many questions about a phenomenon, setting or an object Our methods of teaching in vogue are not only didactic in character but also devoid of constructive imagination (Vaidya & Sukumaran, 1978). The science teacher like the teacher of language, talks too much dogmatically on prescribed topics of science which in turn are remotely related to the behavioural objectives of science education Because of old traditions in his local set up, he sees no relevance in stimulating and cultivating scientific and technical talents (Vaidya, 1977) and consequently there always remains a diminished pool of swift sceptical, curious, and young vibrating minds to run the race in science (Vaidya, 1974). Students leave the science course convinced that the most important characteristic of science is its experimental conclusions. Scientists have been disturbed about another aspect of the emphasis placed upon teaching the conclusions of science Though Popper (1959) thinks that every scientific statement must remain tentative for ever, it stabs our emotional body to know that our students of science are rarely told that what they are reading in the textbook represents only our present conclusions about a body of scientific knowledge, and they are never made aware of the fact that science is an ongoing activity and no statements are absolutely certain In educational terms we have not yet fully understood the role of science as a decisive factor in training all parts of the personality and in meeting its demands Faure, et al. (1972) have stressed that science is not an agglomeration of 'bits of learning' and intellectual instruments to be fastened on to an individual who otherwise persists in all his traditional attitudes and behaviour

1.3. Creativity, Science and Society

In modern civilization men can only participate in production if he is capable of understanding a certain number of scientific methods. At present

man can only properly perceive and understand the universe in which he finds himself to the extent that he possesses the keys to scientific knowledge. The standard of living of Indian people is to be raised and the accomplishment of this ideal is contingent upon rapid industrialization, utilization of its natural resources and technological advancements The prerequisite for such a state is the nurturance of creative talents of potential scientists. Thus it is apparent that there exists an intense demand for the identification and nurturance of creative talents in the field of science. Skraly (1982) has aptly remarked, "As we become a more technological society, the need to identify those students who excel in both science and creativity becomes more critical It is not only the identification of these individuals that is important, but also the special educational experiences provided for them that will develop their special gifts" The time has come for us to think seriously over our behaviours to ensure that a distorted vision of man and the universe, ignorance, violence and collective psychoses causing it, powerlessness, domination suffered and repressed, and fear of freedom, all do not converge in such a way that action and critical thought destroy each other.

We believe that in education, whether formal, informal or non-formal we have the means of developing creative talents in science. T N Raina (1973) realized the imperative need to reform—in fact to revolutionize—the whole educational system in this country to desanctify and render dysfunctional the repressive role of the contemporary conformist and authoritarian mummified cultural and social institutions that hinder freedom, growth, spontaneity and creativity Creative science education has to reach the millions of classrooms and the glorious manifestation of scientific creativity is to be made possible There can be no controversy about Stoddard's observation that in creativity we have the essence of what is worth saving and in education we have the means So, India has a moral duty to ensure that scientific creativity is given free play. Creativity does not spring forth out of a vacuum. (Trabue, 1962) The chance development of this capital asset is risky We must remember Gowan who says that most of us are like some unfortunate women who find it easy to conceive but hard to carry them to term We continually get ideas but we continually abort them Often this is because the creative idea does not occur in a proper or "evening dress" form Like most things just born, it needs to be nurtured, loved and cleaned up. Thus accurate identification, appropriate education and effective use of creative talent in science is the need of the hour. On the one hand our science curricula, textbooks, and teacher-guides need radical alterations and on the other hand such conditions are to be generated as will be conducive to the development

of creative thinking in science so that Indians may not be forced to live a miserable life

1 4 Role of Environment in the Development of Creativity

Creativity can be developed According to Guilford (1980) determiners of creative production lie both within the individual and environment, provided by his family, his school and his working milieu. Anderson, et al.(1970) think that creativity in science depends upon the environment into which it is introduced and circumstances that condition it. Despite research done in the past and currently in progress little is known about those experiences and conditions that foster creativity. However, we will try to analyse the environments that may influence creativity

Sandler, Taylor and Doin(1977)think of creative processes as transactualization, taking into consideration the environment. Creative behaviour from this point of view was defined as a system in which a person designs or transactively shapes his environment by transforming basic or generic problems into fruitful or generative products in a facilitating, stimulating climate Creativity can not be forced, it can only be fostered. But a sympathetic and flexible external environment for learning can support and provide scope to the complex internal process by which the ego recognizes and explores its own powers and shapes them towards that creative expression best suited to its capacities Weininger (1977) has reasonably assumed.".. the creative potential which exists within all of us in various forms, is seriously curtailed or distorted when unconscious conflicts so threaten the ego that it must protect itself by repressing all powerful feelings The amount of energy required to repress any expression or communication of tenderness, unhappiness, or anger is enormous e g. a child who is not allowed to express emotions may grow into an adolescent or adult who thinks of himself as virtually without feelings and incapable of any sort of creative expression " As Segal (1975) says that excessive pathological defences against the toleration of internal depressive anxieties, such as the manic, the schizoid and the obsessional, are immediately reflected in the artistic product They interfere with the recipient's own creative experience. Hasnain(1977)thinks that creativity blossoms in a stress-free environment. Thus, it is safe to assume that environmental conditions may help or inhibit the development of scientific creativity However, this psychological uranium is a potentiality and therefore the limits of its development in an individual will be set by nature while the environment will determine the extent to which his potentiality shall be realized, the specific forms in which it shall be developed, and the directions in which it shall be utilized. Just as a seed with potentiality to develop and grow into a plant germinates into a seedling which grows into a plant only

when suitable environmental conditions exist, in the same way if a congenial environment conducive to the development of creative potential is not available, the potential is bound to be smothered and our nation and culture will fail to withstand the danger of extinction Our society will have to give up its business to stifle, stunt and stultify the potential creativity by the prevalence of adverse attitudes of mind and habits of behaviour so that we, the Indians, may not be forced to live a tense, sad, pessimistic and charmless life.

India has, thus, brought upon herself a retribution for which she has only herself to blame but she can no longer afford the prodigal expenditure of creative ability in science or refuse to accept the unusual insights they possess. The country will have to provide congenial environment for the development of scientific creativity among prospective thinkers in the field of science. Thus, scientific creativity is like the seedlings destined to grow, to fill out, if given environment in which this is possible

So far as environment is concerned, both home and school environments will largely contribute to the development of creativity. Torrance (1963) says, "I know fully well that creative performance depends heavily upon home and school conditions, the response to creative needs, and whether creative thinking and creative achievement are rewarded or discouraged" Lancaster (1974) stressed cultural influences on the thinking and activities of all men "The way a person has been raised, his elementary, secondary and advanced education, his friends, his religion, his political group, his neighbourhood all may help or hinder his creative work". There are certain things which are taboo in a society. A person may not know why they are taboo, or when they are taboo, yet he will usually consciously avoid thinking in these areas Certainly the cultural trend at present on integration and adjustments to a group may do much to inhibit productive creative thinking in science. Our society requires practical and economical things and as a result, judgement comes too quickly into play It is impolite to become inquisitive, and it is not wise to doubt everything These are cultural blocks to creativity

1.4 1 Home Environment and Creativity

Environmental influence starts very early in life time i e during the pre-natal development of child The process of birth brings the individual into an environment which is much wider, much more complex and demands active transaction on the part of the infant to some degree. He has to develop in the field of reality(environment) and whether he is an inferior, normal or superior child with reference to creativity depends on

the way those specific realities impose themselves on him The most important part of the child's environment is the home. Family is the society in miniature and the child is in the home and the home alone for the first vital years of his life. When he starts going to school, he is there only for a part of his time (Young & McGeeney, 1968). If we were to calculate how many days are spent by a child in a school, we come across that he is in the school only for about 200 days in a year He studies only for about six hours and the rest of the time is spent by him at home, in the streets, or wherever he takes recreation. Douglas (1964) found that although teachers genuinely intended to stream children according to their measured ability, they none the less allowed these judgements to be influenced by the type of home the children come from Musgrove's study (1963) shows that even in a school where pupils from diverse communities appear to be fully integrated into the life of the school, this can be superficial and on investigation the underlying differences springing from diverse community backgrounds are likely to remain strong Raina (1969) found that girls are less creative than boys due to the fact that they get less freedom to express themselves Straus and Straus (1968) theorized that children's creativity varies according to the degree to which the child's family role requires conformity to the conventional norms. Sagar and Kaplan (1972) pointed out, "By its nature, the family is the social biological unit that exerts the greatest influence on the development and perpetuation of the individual's behaviour" Ackerman (1958) says that the family moulds the kinds of persons it needs in order to carry out its functions Halasz (1966) examined three groups of subjects —50 writers of fictions, 54 non-writers and 45 artists in relation to evolution of talent The presence of creativity in family was found to be the most influential factor in talent development Child development is continuously influenced by the emotional climate that characterizes the entire family According to Tucker and Bernstein (1979) it is the changing manifold of emotional currents and crosscurrents that defines the unique interpersonal atmosphere of the family and against the background of this family atmosphere, constantly in flux, a child's personality and social reactions are developed Emotional tensions can block the availability of information already possessed for creative use (Traube, 1962) Lancaster (1974) also thinks in the same vein- "Perhaps the largest group of blocks may be classified as emotional. Personal biases always cloud one's thinking They tend to distort the information received from the outside world." Thus, it appears that home environment may significantly dwarf all of the children's imagination, stifle the creative interests or help the development of scientific creativity. This opinion gains more strength when we examine Cropley's views on

'Creativity and Culture' He thinks that the process of socialization leads to considerable stereotypy in the behaviours of members of a given society. In a given culture a socially stereotyped band of highly desirable behaviours exists along with a penumbra of tolerable behaviours and an area of undesirable, ill-mannered or even proscribed behaviours. An individual is normally restricted to emitting behaviours which lie within the tolerable limits of his society, and suffers various punishments if his behaviour falls into his society's shadow zone Creativity may be conceptualized as a social phenomena, with the creative person being distinguished by a disposition to behave in poorly socialized ways. Despite their obvious and real utility, socialization processes have anticreative side effects, in that extremely clear-cut, strongly preserved and observed societal norms militate against the appearance of widely divergent behaviours in a culture and hence against creativity (Cropley, 1973). Thus, home is a starting point in the life of an individual and various factors of home environment may affect the development of scientific creativity.

1 4.2. The School Environment and Creativity

Next to the family, the school is the most important experience in the process of child development It is very important for the development of scientific creativity Gupta(1978)points out that during childhood creativity may be easily discouraged and one of the most convenient places where this can be accomplished is within the four walls of a school Pulsiver (1963) stresses attempts to avoid the striking negative effects of schooling and Weininger (1977) supports her by saying "It is clear that all too often schools seem to stop the flow of children's original and creative expression." Jarrett (1981) criticized the schools for being concerned with rationality and practical knowledge and for ignoring other human capacities and functions such as intuition which is related to originality and novelty insight The type of school or institution in which a child is studying is said to influence creativity (Snyder, 1967, Heist 1967, Haddon and Lytton, 1968, Lunn, 1970) The value of a creative classroom environment is gaining increasing support in educational literature (Pullan, 1971, Rathbone, 1971; Barth, 1972, Blitz, 1973, Frazier, 1976; Schempp et al., 1983, Guili and delli Santi, 1983) Smith and Torrance (1967) maintain that the role of the teacher is to set the conditions for creativity to happen Heck (1978) reports, "Within a truly creative classroom environment the teacher assumes the multi-various roles of a guide, questioner, listener, interactor, model, motivator, planner, researcher, and resource person" Goodale (1970) suggests that the teacher, to be an effective encourager of creativity, must be interested in fostering curiosity, independence and self

reliance Butler-Arlosoroff (1982) identified two factors necessary for the promotion of creativity (1) Psychological safety to experiment, to make errors and to bring forth unfinished thought products, without being afraid of harsh external evaluation; (2) Psychological freedom, which implies giving the individual complete freedom of symbolic expression, thereby encouraging the spontaneous juggling of ideas, concepts and meanings. Accroding to Anderson, et al (1970) · "Creativity flourishes in a creative classroom atmosphere, thinking processes are automatic, swift, and spontaneous when not disturbed by other influences .. ...children create best in an atmosphere that is relaxed, where individual contributions are respected regardless of their merits and where a democratic situation prevails .....Creativity as exhibited by certain students in the arts is no guarantee that the same individual will be creative in the solution of problems in science or math. Specialization within the individual may already have begun. To aid in the transfer of this creativity to other areas is both your privilege and your responsibility". This scientific creativity begins with the teacher and it inspires scientific creativity.

Thus, we see that home and school environments are the most important variables that should influence child development in general and growth of scientific creativity in particular Williams(1967) also observes that creativity may be developed during the very early life of the child through attitudes of both parents and teachers There exists a unique juxtapposition of and interrelationship between the school and the family, in that they both share an influential space in the child's life. The concept of child as an integral member of a larger dynamic system, the family, and the school's expansion of commitment to this larger unit are relatively new (Aponte, 1976, Freund and Cardwell, 1977, Tucker and Dyson, 1976). Schecter(1983) stressed the need to encourage children's imaginative creativity even while their cognitive development and social pressures are pushing them toward objective reality based thinking. Systematic research into various factors of home and school environments which influence the development of scientific creativity is very much needed in the prediction of creative functioning Though this issue requires intensive and extensive study by a team of research workers working steadily over a number of years, yet the investigator has taken an humble venture to find out the aspects of children's home and school environments that may influence the development of scientific creativity among students in the formal operational stage of cognitive development

The present study on *Effect of Home and School Environments on Scientific Creativity* was intended to answer the following questions :

1 Are home and school environments related to creative thinking in science ?

2. Which of the environmental characteristics are associated with scientific creativity and in what manner ?
3. Do different levels of home environment and school environment influence scientific creativity in different measures ?

1.5 Objectives of the Study

The major objectives of the study were :

1 to find out effects of home and school environments on scientific creativity,

2 to find out the extent to which home environment is related to scientific creativity,

3 to find out how school environment influences scientific creativity,

4 to find out how far various aspects of home environment as well as school environment contribute to the prediction of creative behaviour in science,

5. to find out whether children with high and low scientific creativity differ in their perception of home and school environments.

In the process of accomplishing the above mentioned objectives the following subsidiary objectives have also been realized—

1 to develop "Home Environment Inventory",

2. to develop "School Environment Inventory";

3. to develop tests to measure scientific creativity,

4 to find out whether boys differ from girls with respect to their scientific creativity.

1.6 Theoretical Basis of the Problem under Study

1 6.1. Determinants of Creativity ?

Creativity is a cognitive variable (Maslow, 1966; Guilford, 1966, Paramesh, 1971), but it is not entirely a cognitive process. It is also a personality variable, however it is not entirely a result of complex set of personality traits (Shukla and Raina, 1972, Dellas and Gaier, 1970; Stein, 1956, Hudson, 1966). The present research has to do with the environmental determinants of scientific creativity. The question arises "where should we look for the determinants?" Answer to this question was sought within the framework of Freud's Psychodynamics of Thinking as well as Piaget's theory. Gowan (1967) examined four theories of creativity and two of them lend support to the answer.

1 6.2. Freud's Psychodynamics of Thinking

The possibility of drawing upon psychoanalysis in studying the psychology of thinking was brought strongly to the fore by the appearance of a larger volume, assembling papers on the organization and pathology of thought (Rapaport, 1951). A fundamental distinction within the psychoanalytic theory of thinking is that between primary process thinking, which is impulse driven and largely irrational, seeking immediate gratification at all costs even by way of hallucinations, and secondary process thinking, which is patient and logical, willing to postpone gratification for future gains. Adult thinking falls somewhere between these poles, either oscillating between the two modes or combining in some manner(Hilgard, 1962). Kris (1952) stressed the importance for creativity of "regression in the service of ego" by which he meant a partial and reversible regression in which the freedom of primary process thinking was utilized for assembling the fantasy material that could then be sorted out and refined by way of secondary process thinking A similar idea was employed by Koestler (1964) who has given one of the more intelligible and respectable discussions of creative thinking

Creativity may be assumed to be the function of environ mental factors and the personality of the individual child Writers on psychoanalysis often stress that it is a genetic (developmental) as well as a dynamic theory (Hartmann and Kris, 1945). This theory suggests that the influences to which the young child is susceptible unusually will leave a permanent mark on his creativity. While the problems have not been formulated clearly in terms of learning i e why and in what manner the results of childhood learning are more permanent than later learning, there are some kinds of evidence supporting the grossfacts of consequences in adulthood of early childhood experiences (Wolf, 1941; Beach and Jaynes, 1954, Whiting and Child, 1953, Nijhawan, 1971). The prediction that parent's authoritarian attitudes would make a child submissive, lacking in security and independence who would, therefore, be less popular with his companions, has been borne out in researches by Read (1945), and Radke (1946) The authoritative parents are dominating and show insufficient respect to the youngsters as individuals Such parents have no room for the child's free expression of his feelings of hostility towards parents One of the most impossible things for such parents is to listen to a new idea from their children They make certain rules to control the behaviour of their children and these tight controls often exacerbate the dependency authority syndromes of the child and either impede creative responses or channel creativity into rebellion (Gibb, 1966) On the other hand, if parents permit

children opportunities for democratic participation in home and they are given a measure of confidence and support by parents, such conditions will be created in which children initiate, feel responsible for this process and feel free to create their own goals According to Gibb (1966) in this situation children create more internal conditions which maximize the growth of creativity But these parental child rearing behaviours will be influential only when they are perceived to be so by their children Thus, children's perception of certain child-rearing behaviours of their parents may promote or inhibit the growth of creativity.

Gowan's examination of two theories of creativity viz "Creativity as sound mental-health" and "Function of the child's oedipal response to the affectional approach of the opposite sexed parent theory". lends support to this answer.

1.6 3 Creativity as Sound Mental Health

This view of creativity, which owes much to Maslow, sees creativity in terms of complete character integration or lack of barriers between the conscious mind and its preconscious areas

While it is incumbent upon the child to develop emergent synthesizing abilities at higher actualizing levels, it is incumbent upon society to see that his prior needs are satiated to the extent that he can devote his energies to intellectual tasks The child who is insecure about love and safety needs is too preoccupied to apply himself

1 6 4 Creativity : Function of the Child's Oedipal Response to the Affectional Approach of the Opposite Sexed Parent

The above function is a final and somewhat original theory of creativity According to this theory, during the period from four to seven the child, enchanted by the warm affect of the oppositesexed parent responds to this in the only way he can-by the creative manipulation of his immediate environment, and by an enlargement of the bridge between his fantasy life and his real world.

1 6 5. Piaget's Theory

The central assumption in Piaget's (1967) analysis of cognitive change is his belief that development depends upon a continuous interaction between organism and environment—an interaction which involves, on one hand, environmental forces (people, objects, events) acting upon the child and on the other hand, the child acting selectively upon the environment Piaget thinks, "The human being is immersed right from

birth in a social environment, which affects him just as the physical environment." Society, even more, in a sense than physical environment, changes the very structure of the individual because it not only compels him to recognize the facts, but also provides him with a ready-made system of signs and it imposes on him an infinite series of obligations. It is, therefore, quite evident that social life may affect creativity as it affects intelligence through the three media of language (sign), content of interaction (values), and rules imposed on thought (collective logical or prelogical) Piaget's position can be summarized by his acceptance of Durkheim's theorem that all social realities —values and processes — are created by men The social and ideational world represents no entity without man Such a world is the reflection of the socialization experienced by each individual in his cognitive development. Olson (1970) also observes that experience is absolutely essential to the development of intellectual structures, particularly experiences systematically provided by a parent or in a formal classroom

The mechanism of intellectual progress, Piaget believes, consists of assimilation. That is, reality data (environmental stimuli) are modified to enable them to be incorporated into existing structures Piaget sees the adaptive interaction between organism and environment as involving the complementary processes of assimilation and accommodation Assimilation names the process whereby the organism utilizes something from the environment and incorporates it

Like Piaget (1971), Bruner (1962) also views creativity as a vital aspect of general intellectual development Their cognitive developmental views focus on the reordering of previously unrelated elements (Feldman, 1973). Creativity is associated with moving from one stage of cognitive development to another, restoring equilibrium by reorganizing previously unrelated elements through a new set of rules. The new stage is more stable, inclusive, and encompassing than the previous one (Flavell, 1963).

Gowan (1967) examined a theory of creativity as "the opposite of authoritarianism " This theory visualizes that the compartmentalization, stereotyping and anti-intraception of the authoritarian personality prevents creative functioning Hence, the degree to which we have been tarnished with authoritarian practice diminishes our creative potential, and narrows the possible avenues of creative endeavour This view of creativity suggests that children can be helped to preserve their creativity by nonauthoritarian attitudes on the part of parents and teachers, especially by not having negative evaluations put upon their initial efforts

Parental child-rearing behaviours (which in this study have meant "home environment") have been found to influence the cognitive development of children (Radin, 1971, Epstein and Radin, 1975, Veroff, 1969, Mcclelland, Baldwin, Bronfenbrenner & Strodtbeck, 1958, Beckwith, 1971, Elardo, Bradley and Caldwell, 1975. Bradley and Caldwell, 1976, Kale and Danke, 1976, Langden et al. 1981, Misra, 1983, 1984).

Thus, it becomes apparent that both home environment and school environment may influence the development of creativity No doubt the problems of creativity in education and child–rearing lie, of course, in the question of what methods will best encourage the maximum development of imagination and reason It is often feared by parents and teachers alike that certain classroom or family behaviours supposedly designed to foster creativity actually produce sloppiness and undisciplined thought and action, thus leading to moral and intellectual anarchism Other observers of education and socialization scenes detect a deadening of student imagination which results from heavy classroom and family regulations and discipline of behaviour, and emphasis on memorization and authority of the teacher, parents, printed resources and moral ethics Gaines (1983) reviewed the literature to explain the decline in children's creativity and said that society's teachings during early childhood or adolescence are repressive and only adoloscents gifted with a high degree of creativity have the capacity to continue their artistic develoment into adulthood We find persons who share their veiws with Barron and Bruner in that more creative people have greater tendencies to prefer complex to simple environments, enjoy situations presenting opportu-nities for challenge and innovation, ignore the opinions of their peers and prefer opinions arrived at by themselves, manifest traits such as detachment, commitment and passion, and show strong self confidence Nicholls (1972) has truly pointed out that there is no clearcut agreement concerning what creativity is, nor what factors facilitate or impede it We should remember that research performed on the basis of the intuitive collective opinion approach is bound to produce less precise results than that based on a set of clear criteria. Pfeiffer (1979)observed that many researchers have in fact noted a certain tension commonly arising between practices which are thought to increase imagination and those thought to increase critical acumen. This observation adds to the significance of empirical findings pertaining to the identification of various environmental factors influencing the development of creative thinking in science and the present investigation aims at this.

1 7. Hypotheses

The following hypotheses have been tested—

1. Boys do not differ from girls with respect to their scientific creativity.

2. There is no significant relationship between school environment and scientific creativity
3. There is no significant relationship between home environment and scientific creativity
4. There is no significant relationship between scientific creativity and various aspects of perceived home and school environments
5. Home environment does not significantly affect scientific creativity at different levels of school environment.
6. Children with high and low scientific creativity do not differ from one another with respect to their perception of home and school environments

1.8 Definition of Terms

1.8.1. Scientific Creativity

'Scientific Creativity' is creative thinking through the media of science. There is no universally agreed upon definition of creativity A great deal of mist surrounds the word 'creativity' Since a person can behave creatively in numerous different ways, it is not strange that we have many definitions of creativity. Bennett et al.(1969) who researched the meaning of creativity record that creativity is multifaceted and does not mean the same thing to all people. Writers on the subject have tended to be unsatisfied by each other's attempted analyses and have thus opted for their own It is ironic that social scientists in their attempts to define creativity in precise, operational or measurable terms should so fog its referential meanings as to contribute one of the major problems of research and interpretation in this area of human knowledge (Khatena, 1973) There is much truth in Pfeiffer's(1979) remark " It is a commonplace for educators and social scientists to express perplexity and frustration over the significance of such research due to the supposed fact that each of us can just as reasonably pick and choose the definition of creativity that he or she prefers " The sentiment "The meaning of the word 'Creativity' is fundamentally unclear " persists regardless of the fact that scores of suggestive, explicit and carefully worded definitions of creativity have been formulated through the years (Ghiselin, 1952, Stein, 1953, Lowenfeld, 1958; Rhodes 1961; Barchillon, 1961; Maslow, 1962, Mackinnon, 1962, Lehois, 1963, Eisner, 1963, Yamamoto, 1964, Koestler, 1964, Getzels, 1964, Getzels & C sikszentmihalyi, 1964; Guilford, 1968, Gowan, 1972, Abraham, 1977; Sander, et. al. 1977 etc). Torrance (1967) a leader in the development of tests to identify creative potential defines creativity as —

"the process of becoming sensitive to problems, deficiencies, gaps in knowledge, missing elements, disharmonies, and so on, identifying the difficulty, searching for solutions, making guesses or formulating hypotheses about the deficiencies, testing and retesting these hypotheses and possibly modifying and retesting them, and finally communicating the results"

This attempt to define creativity in terms of the process of creativity is equally useful in all areas of the curriculum in mathematics, science, language, arts, social studies, psychology, music, physical education and human relations However, this definition is very much oriented toward the scientific dimension of creativity Moreover, its length and complexity are unattractive and unwieldy, and it fails to provide a basis for distinguishing products of creative activity from those of less creative work in the field of science Though Poincare (1913), Montmasson (1931) Catharine (1938), Majumdar (1973), Gvishiani et al (1971), Mikulinsky and Yaroshevsky (1973), Zinevich, et al (1980), and various other authors dealt with the nature of creative thinking process in the field of science. Writers have been unable to arrive at any significant consensus as to the sense and degree to which creativity in art is the same as creativity in science or some other field However, on the basis of Torrance's definition, scientific creativity may be defined as "a process of becoming sensitive to problems related to science, deficiencies, gaps, missing elements, disharmonies and so on in scientific knowledge; identifying the difficulty; searching for solutions, making guesses or formulating hypotheses about deficiencies, testing and retesting of these hypotheses and possibly modifiying and retesting them, and finally communicating the results" Operationally speaking, scientific creativity is a multidimensional attribute differentially distributed among people and includes chiefly the factors of fluency, flexibility, originality and inquisitiveness The author also agrees with the views of Sharma (1979) and DeHaan & Havighurst (1961) in that scientific creativity is also a problem solving type fact-finding endeavour which cannot produce ridiculous and inappropriate solutions

1 8 2 Perception of Home and School Environments

The definition of environment for an organism has not followed any single taxonomy A large number of variables have been utilized to describe the environment of an organization In 1950s and 1960s the concept of environment, both for the natural and the social scientists, implied a complex interaction of organisms, events, and conditions This trend was a consequence of technological advances and their adverse effects,

on the physical environments of human beings, particularly water and air pollution. After 1970, a new emphasis was laid on the study of human environments, both physical and social. This new concern was conceptualized as "social ecology" It was defined as a "multidisciplinary study of the impacts on human beings of physical and social environments '

Reddy and Chattopadhyay (1969) thought that organizational climate is a set of characteristics or variables that (a) describe the organization, (b) distinguish the organization from other organizations, (c) are relatively enduring over time and (d) influence the behaviour of people in the organization According to Withall (1979) environment encompasses "the emotional tone which is a concomitant of interpersonal interaction It is a general emotional factor which appears to be present in interactions occurring between individuals in face groups".

(a) Home Environment

The term 'Home Environment' as such or as a synonym of parental childrearing behaviours has been used by many researchers working in different fields Cohen (1979) observed that attitudes are notoriously difficult to define and measure, and the relationship between stated or measured parental attitudes and subsequent behaviour is problematic According to Johnson and Medinnus (1969) the psychological atmosphere of a home may fall into any of the four quadrants, each of which represents one of the four general combinations. acceptance-autonomy, acceptance control, rejection-autonomy, and rejection-control

Acceptance
(Love)

Autonomy—|—Control
(Democratic) | (Autocratic)

Rejection
(Hostility)

Two characteristics recur throughout the studies of Symonds (1939), Baldwin, Kalhorn & Breese (1945), Lorr & Jenkins (1953), and Milton (1958). These are acceptance versus rejection and autonomy versus control Grebow (1973) reports that the dimensions of parental behaviour which have been most consistently suggested as important by previous research are (a) nurturance-affection and (b) achievement expectations, demands and standards (Crandall, Preston & Rabson, 1960, Crandall, Katkovsky, and Preston, 1960, Crandall, Dewey, Katkovsky

and Preston, 1964, Rosen & D' Andrade, 1959, Winterbottom, 1958). Caldwell (1968) surveyed empirical data, developmental theory and expert opinion for clues to home characteristics that might be associated with favourable development during the early years of life. Later he developed an instrument named "Inventory of Home Stimulation" His scale represents following six subscales emotional and verbal responsivity of the mother, avoidance of restriction and punishment, organization of physical and temporal environment; provision of appropriate play materials, maternal involvement with the child and opportunities for variety in daily stimulation Numerous other researchers have identified the following characteristics of home environment or parental child-rearing practices—permissiveness, willingness to devote time to the child, parental guidance, parental aspiration for achievement, provisions for the child's intellectual needs, affective reward, instrumental companionship, prescription, physical punishment, deprivation of privileges, protectiveness, power, achievement demands, affective punishment, principlined discipline, indulgence, neglect, conformity, independence, dependence, etc There exists a great overlapping in the kinds of behaviours which are in association with different characteristics. In the present study only ten characteristics of parental childrearing behaviours have been taken to constitute home environment These characteristics are permissiveness, conformity, nurturance, rejection, reward, punishment, protectiveness, social isolation, deprivation of privileges and control

For the purpose of the present study, home environment has been considered to be a measure of the quality and quantity of social, emotional and cognitive support that has been available to the child within the home This definition is quite similar to the definition of 'Home Stimulation' as given by Caldwell, et al (1975). Index to this environment is to be provided by subjects' composite scores on ten dimensions of home environment which measure home environment characteristics in terms of parental child-rearing behaviours. Operational definitions of these characteristics are as follows

1. *Permissiveness* It includes "provision of opportunities to child to express his views freely and act according to his desires with no interference from parents"

2. *Control* It indicates "autocratic atmosphere in which many restrictions are imposed on children by the parents in order to discipline them".

3. *Conformity* It indicates "parent's directions, commands, or orders with which child is expected to comply by action". It refers to

"demands to work according to parent's desires and expectations".

4. *Nurturance* : It indicates "existence of excessive unconditional physical and emotional attachment of parents with the child Parents have a keen interest in and love for the child".

5. *Rejection* It implies "conditional love recognizing that the child has no rights as a person, no right to express his feelings, no right to uniqueness, and no right to become an autonomous individual".

6. *Reward* . It includes "material as well as symbolic rewards to strengthen or increase the probability of desired behaviour"

7 *Punishment* It includes "physical as well as affective punishments to avoid the occurrence of undesirable behaviour"

8 *Protectiveness* It implies "prevention of independent behaviour and prolongation of infantile care".

9. *Social Isolation* It indicates "use of isolation from beloved persons except family members for negative sanctions".

10. *Deprivation of Privileges* : It implies "controlling children's behaviour by depriving them of their rights to seek love, respect and childcare from parents"

(b) School Environment

'School Environment' has been defined in numerous ways. Dave (1963) defined educational environment as "the conditions, processes, and psychological stimuli which affect the educational achievement of the child". It refers to those forces in the environment of the learner which have the potentiality to contribute to academic development of the learner. These forces may be a part of the shool or college environment, the home environment, or the environment of various other social organizations To Hunt and Sullivan (1974) it consists of school climate as well as the teachers' approach to teaching. They consider such activities as teaching methods, and institutional programmes as well as school climate to be features of the educational environment However, this division appears to be unnecessary. Hall (1970) included the dimensions of interaction facilities, willingness to change, students' autonomy, feedback on students, instructor's contribution and task concern Bhatnagar (1977) observes "The unique quality of the environment largely depends upon specific ways the pupils are treated in the school and the classroom" He defined the concept of "Treatment Environment" as the product of the interactions between the teachers and the pupils in school situations. Perkin (1951) concludes that quality of teacher-pupil rela-

tionship in the class is the major aspect of classroom climate. Many other researchers have defined environments in terms of certain global characteristics. Yet a standard taxonomy of the school environment has not emerged out of these attempts

For the purpose of this study school environment implies "a measure of the quality and quantity of the cognitive, creative, emotional and social support that has been available to the subjects during their school life in terms of teacher-pupil interaction" Many researchers and authors have identified the following characteristics of school environment or teacher-pupil interactions disengagement, esprit, intimacy, product emphasis, psychophysical hindrance, alienation, control, humanized thrust, friction, cliqueness, satisfaction, speed, apathy, difficulty, favouritism, formality, direction, diversity, disorganization, democratic independence, enthusiasm, divergence, humour, teacher talk, homework, teaching methods, learner supportive, acceptance, problem structuring, neutral, directive, reproving, disapproving or disparaging, teacher supportive, accepts feelings, praises or encourages, accepts or uses ideas of students, lectures, gives direction, criticizes or justifies authority, student-talk response, student-talk initiation, and silence or confusion etc. On the basis of views expressed by Amidon and Flanders (1963) and Withall (1979) and findings of Misra (1978-79) the author has included six characteristics viz. creative stimulation, cognitive encouragement, permissiveness, control, acceptance and rejection in the School Environment Inventory developed by him These characteristics are defined as enumerated below

1 *Creative Stimulation* . It refers to "teachers' activities to provide conditions and opportunities to stimulate creative thinking".

2 *Cognitive Encouragement* It implies "teachers' behaviour to stimulate cognitive development of student by encouraging his actions or behaviours"

3 *Permissiveness* It indicates a school climate in which "students are provided opportunities to express their views freely and act according to their desires with no interruption from teachers".

4 *Control* It indicates "autocratic atmosphere of the school in which several restrictions are imposed on students to discipline them".

5 *Acceptance* It implies "a measure of teachers' unconditional love, recognizing that students have the right to express feelings, to uniqueness, and to be autonomous individuals Teachers accept the feelings of students in a nonthreatening manner"

6 *Rejection* : It refers to "a school climate in which teachers do not

accord recognition to students' rights to deviate, act freely and be autonomous persons"

(c) Perception of Environment

This refers to "a product of active commerce with the environment. The individual's perception of and action in an environment are inextricably related processes. How we behave in a setting is a function of how we perceive it" (Ittelson, et al 1974). How one perceives an environment depends on both what a person does in a particular setting and what the setting has to offer him by way of available information In the words of Annes (1951) "perceptions are prognostic directives for action"

For the purpose of this investigation children's perception of home and school environments has been defined as "children's views on the quality and quantity of parental childrearing behaviours and teacher-pupil interactions"

Review of Related Studies

There exists a continuum between the old theories and the new ones Knowledge is dynamic and it always grows along this continuum The past is to be discussed to view a problem in a proper perspective so that a researcher may streamline his efforts to solve the problem. Keeping in view the objectives of the present research, numerous studies pertaining to measurement of scientific creativity, home environment and school environment, and relationship of various aspects of home and school environments with general or scientific* creativity have been surveyed. The former have been described in the relevant chapters on construction of the three tools, while the present chapter deals with the latter type of studies.

2 1. Home Environment and Creativity.

Several studies have been performed to investigate the relationship of various factors in home environment to general creativity Some of the notable researches are as follows

2 1 1 Home Environment and General Creativity.

Baldwin (1949) found that parental democracy stimulates creativity and imaginativeness among children

Terman (1954) in his comparison of creative as opposed to noncreative gifted children showed that the noncreative came from homes having more stress, more conflict, and less interest in achievement than homes of creative subjects

McCurdy (1957) demonstrated that historic geniuses had intensive, generally warm relations with parents. Greenacre (1958) also found this to be true.

*In this study scientific creativity refers to creative thinking through the media of science.

Watson (1957) on the basis of projective tests and teachers' ratings, found that children from the more permissive families were rated as having significantly greater spontaneity, originality and creativity, accompanied by more initiative and independence All children in this study had an IQ of 110 or above

Roe (1960) found parents of the social scientists to be overprotective and firm, and control, even if not overt, was very evident

Ornstein (1961) reported no evidence about the positive relationship between the permissive child-rearing attitudes of mothers and high creativity after the child's IQ and the mother's need for socially approved behaviour were partialed out

Weisberg and Springer (1961) report a correlation of 5 between the integrity of the father-child relationship and the level of creative test performance Compulsivity in the mother as rated by psychiatric interviews was found to be negatively correlated with creativity test scores in children.

Gallagher (1964) found that fathers who exerted strong control over their son's activities had sons who performed better on divergent thinking tasks and expressiveness in the classroom than did the sons of fathers who were less controlling

Nichols (1964) reported that mothers who were rated high on authoritarian child rearing attitudes tended to have children who were low in creativity and originality

Ellinger (1964) found that highly creative fourth grade children were more involved in family activities and experienced less coercive discipline, especially of a physical nature than their less creative peers.

Talented architects in MacKinnon's study (1965) reported having as children an unusual amount of freedom in making decisions and exploring their environment, they experienced neither overprotection nor rejection from their parents, but at the same time parents set definite standards of conduct and values and provided a model for identification

Dryer and Wells (1966) concluded that the parents of the more creative children (as assessed by TTCT) showed less consensus in family values, and more role tensions than the parents of low creatives However, the extent to which the parents granted autonomy to the child did not differentiate the two groups of parents

Nuttal (1969) hypothesized that there would be a positive relationship between creativity and parental acceptance and autonomy. This

study had two phases In the first all the boys attending the sixth grade (N=189) in a suburban predominantly middle class community were given the MTCT Their teachers were asked to rate the creativity of all the boys on the teacher rating scale The second phase included the boys who scored on the upper (N=45) and the lower quartile (N=50) of the MTCT These boys were labelled high creative boys and low creative boys respectively. The parents of these boys answered the Parental Attitude Research Instrument (PARI) and the Maryland Parent Attitude Survey (MPAS) The highly creative and the low creative boys also answered the Child's Report of Parental Behaviour Inventory (CRPBI) It was found that-(1) high creativity would be positively correlated with high parental acceptance and autonomy when teachers ratings were used as a criterion of creativity and the CRPBI was used to measure parental attitudes, but when the MTCT were used, it was not found, (2) teachers' ratings of creativity were positively correlated with the maternal acceptance factor, and negatively correlated with the maternal firm control factor of the CRPBI, (3) the correlation between the total MTCT scores and teachers' ratings of creativity was not significant (=.15).

Straus and Straus (1968) theorized that children's creativity vari according to the degree to which the child's family role requires confc mity to conventional norms Creativity was measured by the ability generate ideas which might solve a puzzle presented to family grou Data for 128 Indian and American families showed that Indi children had lower scores than Americans Girls' scores were lower th boys' in both societies. Sex differences in creativity were great in India. The smaller sex difference in American sample was interpre as reflecting the greatest freedom permitted to American girls It concluded that individual creativity is likely to increase as societies m toward a less restrictive normative code

Silverberg (1970) designed a study to investigate relations between children's perception of certain basic parental child-rearing haviours or attitudes namely, acceptance and permissiveness, and creativity of these children. 'Torrance Tests of Creative Thinking' the 'Cornell Parent Behaviour Description' were used as a measu creativity and of children's perceptions of parental behaviour. The jects of the study were 205 middle class IV grade boys and girls boys and 117 girls) selected from 6 public elementary schools in York city Subjects in the superior range of intelligence were ch Analysis of data revealed (1) a significant relationship between f acceptance and fluency for boys, (2) girls' perception of their moth

more accepting than boys, (3) rejection of hypotheses predicting positive relationship between the extent to which children perceived their mothers and fathers as accepting and permissive and the creativity of these children, (4) progressive decrease in father's acceptance with increase from the lowest to the higher (but not the highest) levels of fluency; (5) that at the highest levels of fluency, fluency was associated with the high level of acceptance.

Wade (1971) found that parents of creative adolescents tend to be better educated and more interested and supportive of their children.

Mari (1971) designed a study with a view to compare modern American with traditional Arab rural eighth-grade students in their creative ability. 60 American (30 male and 30 female) and 60 Arab (30 male and 30 female)eighth grade students from farming families in rural area were the subjects. 'Torrance Tests of Creative Thinking' were used to measure creativity It was found that American subjects differed from one another significantly more than Arab subjects. This difference was explained in terms of differences between modern society where individuality is encouraged and required, and traditional society where similarity and group orientation are encouraged and individuality is punished

Walberg (1971) obtained data from 3000 adolescents on self-reported creativity, biographical variables and IQ. He found that adolescent creativity is associated with stimulating home environment.

Heilbrin (1971) found that adolescents with highly controlling and low nurturant mothers lack in creativity than those with mothers rated as converse.

Dewing and Taft (1973) found that the more creative parents preferred a complex and stimulating environment for themselves and their children. Mothers of creative children professed more equalitarian childrearing attitudes and permitted their children more contact with influences outside the home.

Aldous (1975) reports association of girls' novel solutions to controlling behaviour from fathers Maternal controlling behaviours, however, were generally associated with less original solution among both girls and boys Fathers in their demands seemed to be setting standards for more originality while maternal assistance had the effect of narrowing the children's freedom to be original.

Moore and Bulbulian (1976) found that subjects in the presence of an aloof, critical adult were less likely to display incidental task related curiosity and exploratory behaviour and were less inclined to

venture guesses as to the identity of objects than subjects in the presence of a friendly and supportive adult.

Shmukler (1982-83) conducted a follow up study of 73 third graders from an original sample of 114 mother-child pairs who were observed when the subjects were preschoolers It was concluded that an optimal balance between involvement, caring and warmth on the part of the preschooler's mother and a willingness to let the child explore at his/her own pace leads to future creative and imaginative expression.

Fu, Moran, Sawyers and Milgram (1983) examined the relationship between preschoolers' creativity and parental childrearing attitudes. Their results fail to indicate any significant relationship between creativity in children and specific parental variables, as measured through the Parent Attitude Research Instrument

Till now we have surveyed studies pertaining to relationship between home environment and general creativity. Our review indicates the availability of a vast literature on home environment and general creativity. However, the researcher could come across only one study which reported some relationship between home environment and scientific creativity.

2.1.2 *Home Environment and Scientific Creativity*

Stein (1963) reported some interesting results based on the study of biographies of chemists who were engaged in industrial research. His more creative subjects say that they were more distant from either parent and from adults in general than do his less creative subjects. Parents of more creative subjects were more inconsistent in their attitudes towards them than those of less creative subjects.

2.1.3 *Analysis of Findings*

Analysis of studies pertaining to the relationship of home environment factors with creativity revealed that .

(i) home environment influences general creativity in particular and may also contribute towards the development of scientific creativity.

(ii) highly creative children have highly controlling parents (Roe, 1960, Gallagher, 1964, Aldous, 1975). Parental control may lead to the development of low creativity (Heilbrin, 1971; Ellinger, 1964, Straus & Straus, 1968; Terman, 1954) However, Weisberg & Springer (1961), Aldous (1975) and Nuttal (1964) have reported that negative association exists between more parental control and creativity.

(iii) more acceptance or nurturance on the part of parents would help the growth of creativity (Terman, 1954; McCurdy, 1957, Greenacre, 1958, Weisberg & Springer, 1961; Ellinger, 1964; Nuttal, 1964, Heilbrin, 1971; Wade, 1971; Moore & Bulbulian, 1976, Shmukler, 1982-83) Contrary to this finding Silverberg (1970) found that as parental acceptance decreases, fluency increases He and Nuttal (1964) reported no positive relationship between parental acceptance and children's creativity.

(iv) overprotectiveness of parents may favour the growth of creativity among children (Roe, 1960) It may inhibit development of originality (Aldous, 1975) or may have no impact on creativity (MacKinnon, 1965).

(v) parental rejection may (Moore & Bulbulian, 1976) or may not inhibit (MacKinnon, 1965) expression of creative behaviour It may develop scientific creativity (Stein, 1963).

(vi) more permissiveness or autonomy or freedom may help the growth of creative potential of children (Watson, 1957; Straus & Straus, 1968, MacKinnon, 1965, Mari, 1971, Dewing & Taft, 1973, Shmukler, 1982-83). Dryer & Wells (1966) reported that freedom does not affect students' creativity According to Nuttal (1964), Ornstein (1961) and Silverberg (1970) no positive relationship exists between permissive child-rearing behaviour of parents and children's creativity However, Nuttal (1964) reported positive correlation between permissiveness in parental behaviour and creativity as shown by teachers' ratings.

(vii) stimulating environment favours the growth of creativity (Baldwin, 1949; Walberg, 1971; Dewing and Taft, 1973, Fu, et al. 1983)

(viii) more punishment reduces occurrence of creative behaviour (Mari, 1971)

(ix) more parental conformity favours creativity. (MacKinnon, 1965, and Aldous, 1975). The reverse may also be true (Dryer & Wells, 1966; Mari, 1973; Stein, 1963)

Above mentioned products of analysis clearly demonstrate the fact that home environment factors separately or as a whole may influence the development of creative thinking. Unfortunately results of different studies are not conclusive They do not enable us to draw common con-

clusions because of the use of diverse tools, techniques, designs, and contradictory and unexpected results of these investigations. Though studies by Davis and Havighurst (1946), Maccoby and Gibbs (1954), Bronfenbrenner (1958), Miller and Swanson (1958), Hoffman (1961), Johnson, Johnson and Martin (1961), Weisbender (1968), Lawson and Ingleby (1974) and Scheck & Emerick (1976) clearly indicate that parental childrearing behaviours (=home environment) vary among various socioeconomic or social classes, no serious effort has been made to partial out the effects of socio-economic status This fact challenges the validity of findings of various researches concerned with the relationship of home environments with general creativity

2.2 School Environment and Creativity

In the preceding pages we surveyed and analysed various researches pertaining to explorations of the relationship between home environment and creativity (general as well as scientific). Now an attempt is made in the following paragraphs to review the studies pertaining to school environment and creativity (general & scientific).

2.2.1 School Environment and General Creativity

Among the institutional environment factors affecting creative abilities, the role of classroom interaction between teacher and the pupils is very important The school environment is so vast that researchers have invariably faced peculiar difficulties in assessing precisely what is in a classroom or in the school which can influence creativity of a child (Govatana, 1977). Results of Morrow's study (1984) reaffirmed the the importance of teacher's role in esablishing a classroom atmosphere conducive to growth in student creativity Teachers' question-asking-behaviour which may be either divergent or convergent depending on whether narrow factual (reproductive) or open (productive) questions are asked, seems to have a direct bearing on creativity (Burkhart, 1962, Torrance and Hansen, 1965, and Flanders, 1970). Disagreements, arguments, debates, and diverse information and ideas are all important aspects of gaining creative insight. Such interpersonal interaction increases the number and quality of ideas, feelings of stimulation and enjoyment, and originality of expression in creative problem solving (Bahn, 1964, Dunnette, Campbell, & Jaastad, 1963; Triandis, Bass, Ewen, & Mikesele, 1963, Bolen & Torrance, 1976) There is evidence that controversies result in more creative solutions with more member satisfaction, compared to group efforts that do not include controversies (Glidewell, 1953, Hoffman, Harburg & Maier, 1962; Maier & Hoffman, 1961, Hall & Williams, 1966, 1968, Rogers, 1970) For controversy

to result in creativity, group discussion must be such that members do not feel threatened or under too much pressure (Rokeach, 1960; Stein, 1968, Deutsch, 1969).

Torrance's studies of development patterns throughout the elementary grades have made him especially alert to the damping effect of the school system upon creativity. Creative children in the first three grades, specially boys, often have a reputation among other children for having "silly ideas" or "naughty ideas", or are thought of as "wild" by their teachers By the end of the third grade, they have usually learned to be evasive and to keep their thoughts to themselves, with consequent loss of some of that precious spark of originality. The ninth and tenth years are transitional periods for most children. The dynamics of freedom and discipline, integration and diffusion, order and disorder, and expression and restraint become opposite to creativity most vividly at the points in development Torrance (1960) concluded that after the second grade creativity is squelched by demands for conformity.

Moore (1960) devised a method for teaching preschool children to read He allowed his subjects to manipulate freely the keys of an electric typewriter. He gives the learner freedom to operate in his own way, at his own pace, without any extrinsic rewards and pressures. The environment is highly responsive to each action the child performs. He opened the door to creative thinking by maximizing child's autonomy.

Goertzel and Goertzel (1962) read the biograhies and autobiographies of 400 of the most eminent people of the twentieth century. They noted that three out of every five of the 400 eminent people, they studied, had serious school problems. Many of them hated school. Only rarely were these eminent people competent and conforming students.

Elizabeth (1963) reported that freedom and order, properly proportioned, are conditions necessary for the emergence of creativity. Too much order and too little freedom hamper the creative activity. Too little order and too much freedom impede the actualizing of creative act into creative product He pointed out that there must be enough freedom to challenge the individual's creative potential and enough order to provide him the means to actualize this potential. Such a balancing of freedom and order generates a nurturing climate for creativity

Walker (1964) designed a study to examine psychological climate, teacher personality, teaching methodology, student attitudes and student creativity in schools judged to be the type that promote the development of creativity as compared with schools not considered outstanding in this.

In comparison with the traditional schools, the high creative schools were found to have (1) psychological environments characterized by high aspiration level, high intellectual climate, low academic achievement, low group life, low academic organisation, low social form and low vocational climate, (2) less authoritarian but not less rational teachers, (3) more stimulating original behaviour exhibited by teachers in the classrooms. Students exhibited more initiating behaviour and there was more evidence of activities of a creative nature.

Weber (1968) conducted a four year study to test the hypothesis that indirect teacher behaviours foster pupil-creativity more than do direct teacher behaviours. Multivariate composite scores derived from interaction analysis data were used to classify 180 elementary school students (who had the same teacher for grade 1 to 3 and a different teacher in grade 4) as having experienced one of the four teaching behaviour combinations : indirect or direct for all four years, indirect for three years and direct in the fourth year. Students' responses to a creative thinking test composed within the framework of two forms of creative expression, verbal and figurative, were compared with their teacher-behaviour experiences He found that verbal creativity is fostered more under the influence of indirect teacher behaviours, and figural creative potentialities are encouraged under the influence of consistent patterns of teaching behaviours

Haddon and Lytton (1968) found that the informal schools provide an environment which develops qualities of personality that result in a high level of divergent thinking ability The "informal" schools in their study have a relaxed, friendly atmosphere in which children move freely, both within the classroom and in the school generally Children have the freedom of access to the libraries and their work remains unsupervised. The formal schools are not "unfriendly", but one senses a tighter reign and a firmer directive Classwork is more in evidence This superiority of the informal schools was held up in the follow-up study conducted four years later by the same authors (1971)

Lytton aud Cotton (1969) selected two modern schools and two grammar schools Within each pair of schools socio economic background was very similar and the mean VRQs showed no significant difference 143 children (97 boys and 46 girls) tested were 14 years old and in their third year in the school. By consensus among college or department of education lecturers, and local authority inspectors, one grammar school and one secondary modern school were allotted to the formal category and the other pair to the informal category. Results indicate existence of significant differences on the Imaginative Stories

Test in the predicted direction and on the Incomplete Circles Test in the opposite direction Mean scores of children in formal schools were significantly higher on Incomplete Circles Test and lower on Imaginative Stories Test.

Raina (1971) has similarly found that the eighth and ninth grade students in creative school climate perform better on the TTCT variables than their peers in a noncreative school climate

Puranjoti (1972) used Flander's Observation Schedule to record the behaviour of second grade teachers and found that among teacher behaviours the encouragement of self-initiated pupil talk and teacher's acceptance and use of students' ideas correlated positively with measured creativity of students

Goyal (1973) designed a study to investigate the effect of schoo climate on creative performance, to find out relative effects of openness' and closure of environment on the development of student creativity in schools 300 boys of VI, VII, and VIII grades studying in three schools of Patiala district in Punjab formed the sample of the study. Three tests on the lines of Torrance's, namely (1) unusual uses test, (2) consequences test and (3) common problems test were constructed by the investigator. Findings revealed that creative potentialities unmask themselves in an "open system" of education and flourish in a "responsive" and "stimulating" environment. Thus, the more open the "system" of education and the more "responsive" and 'stimulating" the environment in a school, the more is the evidence of the development of creativity He also observed that the death knell to creativity is rung in a school where environment is surcharged by conformity, rigidity, strict obedience and traditionalism

Wilner (1974) found that the nonevaluative conditions produced significantly greater total number of responses, total number of unique responses and combined fluency and uniqueness scores (creativity index) than did the evaluative conditions, and the no-time-pressure conditions produced significantly greater total number of responses than did the time-pressure conditions.

George (1976) found that there was no significant relationship between creative teaching process and indirect/direct behaviour of teachers However, the high creative teaching process group of teachers were indirect in their classroom behaviour as compared with the low creative teaching process group of teachers. When the Darwin's likelihood ratio criterion was employed, the composite matrices of the high

and low creative teaching process groups of teachers revealed significant differences between them He also found significant negative relationship between creative teaching process and divergent-question ratio. There was no significant relationship between creative teaching process and the remaining dimensions of teacher behaviour considered in the study.

Govatana (1977) studied creative thinking in relation to socio-economic status, school climate and classroom behaviour of high school students. This was a cross cultural study He found significant differences between open school eimate group and closed school climate group on the dimensions of creativity as measured by the Passi s Tests of Creativity. Such differences were not found when Torrance Tests of Creative Thinking (Figural Version, form A and Verbal Version, form B) were used.

Gupta (1978) explored the differences in the mean levels on different dimensions of verbal and nonverbal creativity among pupils aged 12-17 years. He found that pupils in private schools obtained significantly higher mean scores on verbal creativity dimensions, namely fluency, flexibility, originality, and creativity than their counterparts in the government schools The former group also obtained significantly higher mean scores on the nonverbal creativity dimensions, namely fluency, flexibility, complexity, elaboration, productive designing ability, novelty, and creativity. This study was conducted on 700 pupils studying in all four higher secondary schools of Jammu city and verbal and non-verbal batteries of MIER Tests of Creativity in Hindi (developed by A K. Gupta) were utilized for the measurement of creativity

Misra (1978) studied anticreativity climate He administered a list of classroom characteristics to 100 student teachers who expressed their opinions regarding whether a classroom climate characteristic will foster creativity or smother it Following characteristics have been regarded by 90 per cent of student teachers as anticreativity harsh, repressionistic and imposed discipline, making students believe in what the teacher says, using lecture and demonstration methods in a traditional way for teaching various units, giving so much written work to students that they are unable to think over a problem, no emphasis on previous experiences of children, authoritative teaching based on one textbook only, nonavailability of good books, no scope for independent study on the part of students, punishing students when they think divergently and independently, no motivation for self-initiated learning; providing negative reinforcement to students when they express opinions against teacher's views, motivating students to study one book only, making students passive listeners; never allowing students to ask

questions, rebuking students for their uncommon ideas quickly, assuming all students to be alike, having only one type of ability, interest, attitude, aptitude and academic standard, etc , never promoting development of scientific thinking, killing students' curiosity to gain new knowledge; teaching the best content matter only He also observed 150 periods in 36 classrooms of seven schools and found that in 86 per cent of the observed classroom climates all the above mentioned anticreativity climatic conditions existed

Horwitz (1979) reviewed 33 studies pertaining to creativity and open education. Twelve of them indicated that children in open classrooms were more creative than children in traditional classrooms, ten showed mixed results and eleven found no significant differences No study favoured the traditional classroom.

Gupta (1980) studied the relationship between institutional climate and classroom teaching in relation to creativity of pupils MIER 'Tests of Creativity' were employed to measure verbal and nonverbal creativity of 310 ninth grade pupils from schools of Jammu city. Hindi adaptation of Joshi's 'Institutional Climate Inventory' was used to measure the institutional climates This study revealed the existence of no significant difference in the composite creativity scores of pupils studying in different types of institutonal climates, significant but low relationship between institutional climate and verbal/nonverbal creativity, and insignificant relationship between classroom teaching verbal behaviour and nonverbal creativity. The mean level of verbal creativity was found to be significantly higher in the need-unfulfilling type of institutional climates as compared to their counterparts in the need-fulfilling and laissez faire institutions respectively Pupils studying in the laissez faire institutions had a significantly higher nonverbal creativity level than their counterparts in need-fulfilling institutions The type of institutional climate (need-fulfilling, laissezfaire, and need unfulfilling) when taken as an independent variable was found to have insignificant effect on the verbal, nonverbal, and composite creativity of pupils. The interaction between institutional climate and levels of creativity when taken together was found to be insignificant with respect to verbal, non-verbal and composite creativity of pupils. This study shows the need of different sets of conditions for the development of verbal and non-verbal creativity. Pupils with lower/average level of verbal creativity are likely to improve upon their creativity levels in need fulfilling climates under authoritarian teacher while those with higher levels of verbal creativity or average level of composite creativity

are likely to improve upon their creativity levels in institutions with laissez faire climates and under the authoritarian teachers Pupils with high/low level of non-verbal creativity or low level of composite creativity are likely to improve their creativity levels under democratic teacher in institutions with laissez faire climates Pupils with high nonverbal creativity or low overall creativity are likely to improve upon their creativity levels under authoritarian teachers in institutions with need-fulfilling climates. Pupils whether high, low or average in nonverbal creativity are likely to improve upon their creativity levels in institutions with need-unfulfilling type of climate in the classrooms of democratic teachers It was concluded that the classroom verbal behaviour of a teacher or his teaching style on the one hand and the institutional climate of the school on the other, cannot be treated as variables which independently, can adequately predict pupils' creativity

Thomas and Berk (1981) examined the effect of three types of school environments—informal, intermediate and formal—on changes in figural creativity over the school year for 225 first and second graders. Children responded to the 'Thinking Creatively with Pictures' subscale of the Torrance Tests of Creative Thinking (TTCT) and teachers completed the 'Behavior Rating Scale'. It was found that school settings rated intermediate on a formal—to—informal continunm lead to the greatest growth in creativity. Girls profited from intermediate and informal environments more than boys.

Gupta and Sharma (1981) carried out an investigation to study the verbal and nonverbal creativity of students studying in 'Need fulfilling' 'Need-unfulfilling', and 'Laissez-faire' institutions These three types of institutional climates were identified on the basis of the magnitude of the degree of correspondence between the need and press scores on ICI, an adapted version of Joshi's 'Intellectual Climate Inventory'. The verbal and nonverbal batteries of MIER tests of creativity were used for the measurement of creativity of 350 pupils studying in ninth grade of ten schools of Jammu city. Results of this study indicate that verbal creativity of pupils is higher in the need unfulfilling institution climates as compared to the same in the need-fulfilling type and laissez-faire institutions However, pupils studying in the laissez-faire institutions have a significantly higher non-verbal creativity level than their counterparts in the need-fulfilling institutions

Houtz and Denmark (1983) administered a Classroom Activities Questionnaire (CAQ) and Torrance Tests of Creative Thinking (verbal forms) to 207 students in grades 4—6 from 14 suburban middle-class classrooms. Ideational fluency was found to be significantly related to

Ss perception of emphasis on higher level thinking skills in the classroom and positive classroom climate These relationships were not changed when the effects of I Q and school achievement were partialed out.

Ahmad (1983) found that verbal creativity is affected greatly by the enriched school environment It was concluded that verbal abilities develop more in a highly enriched but formal environment, while nonverbal ability is equally affected by an enriched formal as well as informal environment

Till now we have reviewed the available literature on the relationship between school environment and general creativity In the following pages studies that were designed to study the relationship between school environment and scientific creativity are reviewed

2.2 2. Institutional Environment and Scientific Creativity

Thistlethwaitte (1959) was interested in discovering some of the factors that influence later creativity and achievement of talented students. His analysis of various studies suggested that scholarly and scientific fields should be treated separately He developed a productivity measure for the natural sciences. Pace and Stern College Characteristics Index (CCI) was administered to 916 of National Merit Scholars and Certificate of Merit winners at 36 colleges Students were asked to indicate whether each of the 300 statements in the CCI was probably true or probably false about their college. Correlations were obtained by correlating the college's median score on each of the CCI scale with its productivity index. He found that Natural Science productivity is associated with student cultures which stress scientism and aggression, outstanding achievement in the natural sciences does not appear in colleges where student cultures stress social conformity He reports significant correlations between productivity in Natural Science and four CCI scales viz, aggression-blame avoidance, scientism, impulsion-deliberation and order Correlations between student press scales, viz, aggression, scientism, and social conformity were ·43, 59, and-·42 respectively. Faculty press scales viz, informality and warmth of student-faculty contacts, closeness of supervision, and directiveness of teaching methods have been found to be significantly correlated with productivity in science, the values of correlations being 43,- 38 and- 42 respectively Significance of the above mentioned correlations was tested at .01 level.

Chambers (1973) studied chemists and psychologists identified as creative on the basis of expert nominations and evaluations of published work The subjects completed questionnaire about teachers who had a significant facilitating or inhibiting effect on their creative work The

facilitating teachers were well prepared for class and taught in an informal manner. They accepted disagreement from students and were likely to use it to stimulate discussion Their students saw them as hard-driving, dynamic and intellectually demanding with a personal interest in teaching and a high level commitment to their field. They gave extensive encouragement to students outside the class Inhibiting teachers were more concerned with memorization of materials and they discouraged independent study They were unenthusiastic and rarely showed originality or creativity in the classroom They had difficulty in accepting disagreement from students Direct reinforcement for students' creative behaviour was not a characteristic of either group of teachers.

Misra (1980) investigated scientific creativity of 57 boys studying in two government schools situated in urban and rural areas. It was found that students studying in the classes XI and XII of these two schools differed in their scientific creativity with respect to flexibility and inquisitiveness Students who studied in a government school situated in urban area obtained significantly higher scores on these dimensions This study does not throw any light on the environmental factors that may be responsible for the observed differences.

2 2 3. Analysis of Findings

Analysis of findings of various researches indicates that stimulating school environment may be conducive to the development of creativity in general and scientific creativity in particular Results of a study by Goertzel & Goertzel (1962) showed that problems faced by creative children in school may not stifle their creativity Horwitz's (1979) analysis revealed that open classrooms may or may not be conducive to creativity. Thistlethwaite (1959) has also shown that energy and controversiality of instruction is negatively correlated with scientific creativity. High intellectual climate may or may not open door to creative thinking (George, 1976, Chambers, 1973, Houtz and Denmark, 1983). A school climate characterized by more permissiveness, freedom or autonomy is favourable for creative expression (Rokeach, 1960, Moor, 1960, Elizabeth, 1963; Stein, 1968, Deutsh, 1969, Chambers, 1973, Govatana, 1977). At the same time Elizabeth (1963) also found that too much freedom and too little freedom impede the actualizing of creative act into creative product. Govatana (1977) found that permissive climate of open schools may not be conducive to creativity Most of the studies (Walker, 1969, Haddon & Lytton, 1968, 1971, Wilner, 1974, Misra, 1978) reveal the fact that less control, as it exists in schools, favours the growth of creativity. Thistlethwaite (1959) obtained negative correlation between scientific creativity and control However, Elizabelth's findings make this

result a dubious one. She reported that adequate control is necessary for the growth of creativity while too much order or too little order hampers creative act Teachers' demands for conformity have been shown to squelch creativity (Torrance, 1960; Walker, 1964, Misra, 1978). Acceptance has been found to promote the development of creativity (Haddon & Lytton, 1968, 1971, Puranjoti, 1972, Chambers 1973). Informal school environment may (Chambers, 1973) or may not (Thomas & Berk, 1981, Ahmad, 1983) be helpful in fostering creativity Gupta (1980) and Gupta & Sharma (1981) have shown that verbal and nonverbal creativity flourish in need-unfulfilling and laissez-faire type of insitutions respectively. However, they observed that institutional climate alone can not influence the development of creativity

Thus, the review of researches reveals two significant points, (1) the relationship of various environmental factors of school with scientific creativity has not been systematically and adequately investigated (2) it is not possible to conclude which of the environmental factors of school promote the development of creativity. Appropriate controls are lacking in these studies. Effects of various intervening variables like personality, socio-economic status, intelligence etc have not been partialed out, and controversies exist with respect to various findings

2.3. Emerging Points for the Present Study

Review of related researches and their results considered earlier do not enable us to draw common conclusions regarding the effect of home and school environments on scientific creativity or creativity in general. However, following points emerge

1. Till now our understanding of home as well as school environment characteristics as perceived by high and low creative students is far from complete None of the areas has so far revealed any set of variables that can be said to have a definite association with creativity in sceince or other fields.

2. Results from individual studies are hardly comparable. The similarity in results of some studies is apparent rather than real because the variables have not been measured by the same test

3. Close examination of studies created the state of confusion regarding the results of various studies This confusion arose from the use of wide variety of tools, use of tools which are not perfectly valid, heterogeneity of samples in the characteristics like age, sex, ability, class, school system, etc. and inadequte control of intervening variables.

4. Diversity in results may be due to difference in the method adopted for the identification of high and low creatives. Because of such

differences in the procedures, it may happen that a person designated as highly creative or low creative by one method may be characterized as a normal creative person by some other method.

2 4 Present Study

The review of research literature related to the problem, as presented earlier, does not indicate existence of even a single study in which variables like sex, area of location of schools, intelligence, personality, or socio-economic-status have been controlled for predicting creativity on the basis of characteristics of home and school environment The present study deviated from the previous investigations in that .

1. It attemptd to explore various environmental characteristics of home and school that affect scientific creativity.
2. Tools to measure 'Scientific Creativity', 'Home Environment Inventory, and 'School Environment Inventory' were constructed and standardized.
3. Verbal, Non-verbal and Performance Tests of Scientific Creativity were used.
4. Sex, verbal and nonverbal intelligence, neuroticism, extraversion, and socio-economic status variables have been controlled

Design of Research

The design of research entails an overview of the total layout including consideration of how the work is to be executed. It is at this stage that crucial decisions are made for how the objectives are to be achieved, what tools are to be used for collecting necessary data, how population should be defined and sampled, what controls, if any, are to be applied, and finally how the data is to be analysed The present chapter embodies a discussion of all these aspects of the present study.

3 1 Method of Study

Researchers in this and related areas have employed different methods of study for investigating the relationship of home and/or school environment with general creativity It is difficult to say which of them is the most appropriate because each method has its own merits and demerits. Methods of research are sometimes determined by the theory related to the problem under study, objectives of the study, and resources of the investigator. These considerations have led the researcher to use the normative survey method of research for the present study

3 2. Population and Sample

Science students of intermediate (Medical Group) classes living at the district headquarters of Agra and Kanpur regions of Uttar Pradesh constituted the population of this study

The investigator selected students of class XI and XII because

(1) Students, during this period, face problems of late adolescence They are jolted by rapid physiological changes, identity crises, and the need to conform to prescribed norms The burden of adjusting to these dilemmas of adolescence may produce overwhelming anxiety and make productive thinking a difficult enterprise for many boys and girls.

(2) Students of these classes usually fall in the age group of fourteen to seventeen when their scientific interests and aptitudes are developing rapidly but are still unstable The youth is able to see that there are no absolute solutions to some problems but he has not yet learned how to apply creatively the principles he has learned about right and wrong (Torrance, 1962). He worries about social acceptance in the school as well as in his own home His fears force him to avoid situations which involve exploration, testing of his abilities and such others.

(3) This is the time for learning the skills of creative problem-solving and for practising the skill of finding third alternatives which are creative solutions He can be stimulated to list all of the things he can and cannot do in hopeless situations (Torrance, 1962).

(4) It is a more important stage of science education. At this stage vigorous efforts are needed to motivate students to learn the basic concepts of science and develop their ability to apply scientific knowledge in various ways to solve various problems. Students are to be encouraged to follow educational and vocational courses related to science

(5) Students in these classes are able to use hypothetical reasoning based on the logic of all possible combinations and to perform controlled experimentation in a limited way These characteristics develop between the ages of 12 and 15 years i e. during the fourth stage of cognitive development which is preparatory to adult thinking (Piaget and Inhelder, 1958)

(6) Thinking is a creative process initiated by the organism, and not simply a response to a stimulus (Piaget, 1970) Individual child structures his experience and during this later stage of child development subjects can exhibit greater amount of creative thinking in science.

(7) A student of science in class XI and XII has a good store of percepts, memories, and concepts to draw upon He is able to do more relational thinking and he has many classes to manipulate in problem solving Their emotional controls, interests, and attitudes may affect thinking (Piaget, 1950). Their thinking may tend to be egocentric and more broadly social because of related developmental factors (Russel, 1960) Such factors may affect the products of child's thinking

In view of the above facts, the author liked to conduct his study on a universe of intermediate science students.

3 2 1. Samples for Item Analysis

(a) The preliminary try-out of the Home and School Environment Inventories was conducted on a sample of 40 students of XI class in Christian Inter College, Farrukhabad.

(b) 127 students (80 boys and 47 girls) studying in XI and XII classes of five randomly selected institutions (situated in the city areas of Mainpuri, Farrukhabad and Kanpur districts) constituted sample for item analysis of the 'Home Environment Inventory' and the 'School Environment Inventory.

Table 3.1 *Sample for item analysis of environment inventories*

S N	Institution	Number
1.	Christian Inter College, Mainpuri	33
2.	Govt Inter College, Farrukhabad	16
3.	B. N S D Inter College, Kanpur	31
4.	Govt. Girls' Inter College, Fatehgarh	27
5	Govt Girls' Inter College, Mainpuri	20

(c) Sample for the preliminary try-out of Tests of Scientific Creativity consisted of ten[1] boys from Christian Inter College, Mainpuri and ten girls from Govt Girls' Inter College, Mainpuri.

(d) 74 students (47 boys and 27 girls) studying biological science in XI and XII classes of four randomly selected schools from Agra and Kanpur regions constituted sample for the item analysis of Tests of Scientific Creativity (TSC). For selecting these 74 subjects first of all author made two lists (one for boys and the other for girls) of such city-area-schools of Agra. Kanpur, Farrukhabad and Mainpuri districts where instruction in Biology was being imparted in XI and XII classes Later on every second institution from the listswas selected. Then, author made contacts with the principals of these institutions and requested them to allow the investigator to administer the 'Try Out Form of Tests of Scientific Creativity'. The administration of these tests required about 140 minutes and because of this some principals did not allow the investigator

1. The subjects volunteered to take the test.

to administer the Tests of Scientific Creativity. As the principals of following institutions agreed to allow the researcher to administer the try-out forms of TSC the researcher had to be satisfied with the available sample of 74 students (This consists of all the students who were present in their classes on the day when the TSC was administered) Their distribution was as shown below

Table 3.2 *Sample for the selection of test items for 'TSC'*

S.N.	School	Sex	Grade	Number
1.	Kendriya Vidyalaya, Kanpur	Male	XI	20
2.	Kendriya Vidyalaya, Kanpur	Female	XI	12
3,	Govt. Girls' Inter College, Mainpuri	Female	XI	11
4.	Govt. Girls' Inter College, Mainpuri	Female	XII	4
5	Govt Inter College, Farrukabad	Male	XI	11
6.	Govt. Inter College, Mainpuri	Male	XI&XII	16

3 2.2. Sample for Standardization of Tools

Sample for standardization of each of the three tools has been described in the relevant chapters on construction of tools.

3 2 3 Sample for the Study.

Eight intermediate colleges (Five colleges for boys and four for girls) where instruction in biological science was imparted, were randomly selected from the colleges situated in district headquarters of Agra, Mainpuri, Farrukhabad, and Kanpur districts 348 students studying in XI and XII classes of these colleges volunteered to take the tests. After eliminating the incomplete test sheets the researcher had to remain satisfied with the data of 197 students (102 girls and 95 boys) because—

(1) he did not want* to force students to supply data about their home and school environments.

* The reason for having this attitude was implicit in researcher's desire to collect relevant and real data about home and school environments of sample subjects. This demanded students' willingness to supply the needed data.

(2) availability of students who volunteered to take various tools could not be ensured in advance i.e. before the planned visits to their schools

(3) convenience of students and principals could not be controlled by the researcher.

The composition of this sample has been shown in table 3.3.

Table 3 3 *Sample for the main study*

S.N	Name of School	Sex	Number of Ss
1.	St. John's Inter College, Agra	Male	29
2	Christian Inter College, Mainpuri	Male	33
3.	Govt Inter College, Mainpuri	Male	21
4.	Christian Inter College, Farrukhabad	Male	07
5.	Govt. Girls' Inter College, Mainpuri	Female	18
6	Kendriya Vidyalaya, Kanpur	Male	5
		Female	5
7.	Murari Lal Khatri Girls' Inter College, Agra	Female	36
8.	Queen Victoria Girls' Inter College, Agra	Female	43

3.3 Variables in the Study

The present study attempts to explore the relationship between various aspects of home as well as school environment and scientific creativity. Hence, there are two major independent variables (1) Home Environment, and (2) School Environment which have been shown using 'X' and '$\bar{X}$' symbols. Scientific creativity, the dependent variable, has been represented by 'Y' symbol Besides these variables, there are five intervening variables, viz Verbal intelligence (Z_1), nonverbal intelligence (Z_2), neuroticism (Z_3), extraversion (Z_4) and socio-economic status (Z_5).

3 4. Tools Used

Suitable tools pave the way for successful accomplishment of the objectives of a study and the collection of pertinent data. The selection of tools for a particular study depends upon various considerations such as the objectives of the study, the amount of time at the disposal of the researcher, availability of suitable tests, personal competence of the

researcher, techniques of scoring and interpretation, and the like. Taking these factors into consideration, the following tools were selected for use by the present researcher :

1. Jalota's 'Group Test of General Mental Ability', (Revised Hindi Version ,1972) was used for measuring verbal intelligence[1].

2 Cattell's 'Culture Fair Test of Intelligence, Hindi Version, Scale 3, Form A, was used for measuring nonverbal intelligence [2]

3. Socio-Economic Status Scale Questionnaire, developed by Kapoor, Singh, Jalota, and Pandey in 1970 was used for measuring socio-economic status of the subjects [3]

---

1. Rationale for using the verbal test of intelligence. Such verbal tests measure crystallized intelligence which is said to be the principal manifestation of a unitariness in the influence of experiential-educative-acculturation influences (Horn & Cattell, 1966). Further, language and cognitive development are interrelated in the sense that one cannot be fully achieved without the other. Language helps cognitive growth by increasing the ability to deal with several alternatives simultaneously, to perform concurrent activities and to allocate attention sequentially to various situations Language also mediates between environmental experiences and behaviour. Thus, it appears important to measure verbal intelligence of the subjects and in order to accomplish this purpose Jalota's Test has been used.

2. Rationale for using the nonverbal test of intelligence Verbal tests use language as a medium and are said to be having some disadvantage of being loaded with cultural connotations of the stimulus and the fixed responses from which the subject has to select his own response (Desai, 1980). Nonverbal tests provide reliable and valid measures of fluid intelligence that is not influenced by cultural variation Thus, it becomes evident that fluid intelligence (i e nonverbal intelligence) may serve as an important intervening variable for our study and culture fair tests have been used to measure this type of intelligence. So, Cattell's Culture Fair Test of Intelligence (Scale 3, Form A) has been used for measuring nonverbal intelligence of subjects.

3. Rationale for using this scale Although Kuppuswamy's original scale has been popularly used by the researchers for measuring socio-economic-status, the present researcher has not used it because our socio-economic conditions have now changed This scale has been used by many present-day researchers and it has been found to yield dependable results

4. Eysenck's 'Maudsley Personality Inventory' (Hindi Version by Jalota and Kapoor, 1965) was used for measuring neuroticism and extraversion

In addition to these four tools three self-made tools have also been used in this study. Tests of Scientific Creativity (TSC) were used for measuring scientific creativity Home Environment Inventory (HEI) and School Environment Inventory (SEI) were used for measuring children's perception of their home and school environments respectively.

3.5. Statistics Used for Data Processing

't-ratios' have been computed for finding out the discrimination index for each item included in or rejected for inclusion in the final form of Home Environment Inventory (HEI), School Environment Inventory (SEI) and Tests of Scientific Creativity (TSC). While computing split half reliability and intrinsic validity coefficients for HEI, SEI and TSC, 'product moment coefficients of correlation' were worked out 'Contingency coefficients' were calculated for determining the validity of TSC.

Kendall partial rank correlation coefficients were computed to remove the possibility whether the obtained correlation between scientific creativity and home/school environment is due to the association between the dependent/independent variables and intervening variables. Relationships between the variables were studied with the help of 'Kendall rank correlations (tau)'. 160 'Spearman rank coefficients of correlation' were computed to determine the relationship between various aspects of home/school environment and scientific creativity among boys and girls.

'Kruskal-Wallis one way analysis of variance' and 'Mann-Whitney U-test' statistical devices were used to test the significance of differences in the scientific creativity of sample subjects perceiving different/same levels of stimulation in home and school environments.

'Kolmogorov Smirnov Two Sample Test' was used to find out sex differences in scientific creativity and differences in the perception of home and school environments by high and low scientifically creative boys and girls This technique was also used to investigate whether children with high and low scientific creativity perceiving equal amounts of stimulation in home and school environments differ with respect to socio-economic status, verbal intelligence, neuroticism and extraversion

SUMMARY

The design of present research can be summed up as shown in table3.5.

Table 3 5 *Design of research*

Objective	Tools Used	Variables (data)	Statistical Analysis
1 To find out effects of home and school environments on scientific creativity	1. H E I 2 S E I 3 T S C	1. Perceived home environment 2 Perceived school environment 3. Scientific Creativity (Overall and various aspects of it)	Kruskal-Wallis One Way Analysis of Variance
2. To find out the extent to which home environment is related to scientific creativity	1 H E I 2 T S C 3 Jalota's Group Test of General Mental Ability 4. Cattell's Culture Fair Test of Intelligence Scale 3, Form A 5. Maudsley's Personality Inventory 6 S E S S Questionnaire	1 Perceived home environment 2 Verbal Intelligence 3 Nonverbal Intelligence 4. Socio-Economic Status 5. Scientific Creativity (Overall & various aspects of it) 6 Neuroticism 7 Extraversion	1 Kendall Tau Coefficient of correlation 2 Kendall Partial Rank Correlation

Objective	Tools Used	Variables (data)	Statistical Analysis
3. To find out how school environment influences scientific creativity.	1 SEI 2-6as used for achieving objective 2	1. Perceived school environment 2- 7 variables-same as mentioned in case of obective 2	1. Kendall Tau Coefficient of Correlation 2. Kendall Partial Rank Correlation
4. To find out how far various aspects of home environment contribute to the prediction of creative behaviour in science	1 HEI 2. SEI 3 TSC	1 Overall Scientific Creativity and various aspects of it. 2. Six aspects of school environment 3. Ten aspects of home environment	Spearman Rank Coefficient of Correlation
5 To find out whether children with high and low scientific creativity differ from one another in their perceptions of home and school environment	1 HEI 2 SEI 3 TSC	1 Overall Scientific Creativity. 2 Overall perception of school environment and six aspects of it 3. Overall perceived home environment and ten aspects of it.	Kolmogorov-Smirnov Two Sample Test

Objective	Tool Used	Variables (data)	Statistical Analysis
6. To find out whether boys differ from girls with respect to their scientific creativity.	1 TSC	Overall Scientific Creativity & Various Aspects of it	Kolmogorov-Smirnov Two Sample Test
7. To develop Home Environment Inventory.	Try out & Final forms of HEI	Home Environment (scores on various items)	(1) t-ratio (2) Product-Moment Coefficient of Correlation
8. To develop School Environment Inventory	Try out & Final forms of SEI	School Environment (scores on various items)	(1) t-ratio (2) Product-Moment Coefficient of Correlation
9. To develop Tests of Scientific Creativity.	Try out & Final forms of TSC	Scientific Creativity (1) Scores on various Tests and items, (2) Teacher ratings, (3) Peer nominations.	(1) t-ratio (2) Product-Moment Coefficient of Correlation (3) Contingency Coefficient (4) Spearman's Rank Coefficient of Correlation

Construction and Standardization of Tests of Scientific Creativity

An individual who appears to be highly creative in dealing with one kind of problem may be quite devoid of ideas in approaching another situation (Wood, 1960). This implies that talent in one aspect of creativity is no guarantee of ability in another area of creativity. Though Lowenfeld and Beittel (1959) think, that creativeness, whether applied in arts or sciences, has common attributes, yet it has not been an established fact that creativity generalizes regardless of content matter area. Zetenyi (1976) found no significant relationship between scientific productivity and creativity Taylor et al. (1961) studied research scientists in the Air Force and found that Guilford's tests of creativity fail to predict the criterion Kanter (1983) investigated the degree to which the TTCT subtests measure scientific and artistic creativity. His results show that neither verbal nor figural subtests are effective in identifying the most creative artists or scientists. Webster and Walker (1981) compared the performance of engineering students and business studies students on two tests of divergent thinking, one of which was oriented towards the interests of engineering students It was demonstrated that the content of the typical open-ended questions used in divergent thinking tests is an important factor affecting performance. It is consistently found that arts students show a bias towards divergent thinking ability while science students show a bias towards convergent thinking ability (Hudson 1966, 1968, Mackay & Cameron, 1968; Field & Poole, 1970). Arts students score higher than science students on tests of divergent thinking (Rump & Dunn, 1971). Webster and Walker (1981) wrote 'in earlier studies science students have not fared as well as nonscience students on tests of divergent thinking simply because the questions asked concerned nonscientific topics" Author shares his views with

Rusch, Denny and Ives (1964) in thinking that the more careful approach (until data can be accumulated to the contrary) in the construction of a test to measure creativity is to design a test for every specific content area. The present chapter deals with studies related to measurement of scientific creativity and the process of construction and standardization of a battery of tests to measure creative thinking in science

4 1 Review of Studies on Measurement of Scientific Creativity

The first ever metric tool constructed to identify scientific talent was the 'Stanford Scientific Aptitude Test' (1925) Recent attempts to the serious functional study of scientific creativity found expression in the first, second and third conferences of Utah on 'The Identification of Creative Scientific Talent' in 1955, 1957, and 1959 respectively. These conferences have opened the flood gates of research in the field of scientific creativity.

Taylor, Smith and Ghiselin (1963) determined fifteen main categories of contributions of which six categories, viz. originality of written work, creativity ratings by high level supervisors, supervisor's ratings on overall performance, judged total work output, productivity in written work and recognition for organizational contributions, were regarded as having creative features.

Mc Pherson (1963) proposes that an examination of the products of research men is one of the best sources for ultimate criteria. According to him, some of the creative products produced by a scientist are patents, patent disclosure, publications, unpublished research reports, unprinted oral presentations, improved processes, new instruments, new analytical methods, ideas, new products and new compounds

Stringham (1937) suggested "Patent Law" which deals with inventive level. According to the law, one who originates novel technology has the right to obtain a patent only if the "quantum of novelty claimed rises to inventive level". Inventive level is to be determined on the basis of characteristics like, use of creative strength to solve the problem; newness associated with the overcoming of special difficulties, and novelty of a combination, a new application, a deletion of a useless part, substitution, etc. However most researchers have been found to be reluctant to use number of patents alone as a suitable criterion for measuring scientific creativity.

Harmon (1963) developed a questionnaire for measuring scientific competence among biological science and physical science (chemists, physicists, engineers, mathematicians, and geologists) groups. The variables extracted from the questionnaire are the number of publications

with partial credit for joint authorship, income from technical and scientific work; number and level of persons supervised, major category of on-the-job activity; and employer category. The author also emphasized the need to go further with his criterion and suggested interviewing the people on the job, their coworkers, their bosses, and so on.

Sprecher (1963) developed a rating form "Creativity and Productivity Survey Form" for describing the meaning of scientific creativity and a similar form, different only in instructions, to describe a particular individual. They include three and six sets of statements respectively and these statements indicate possible characteristics of creative research scientists.

Russel, Buffington and Taylor drafted several scales for internal laboratory use in the rating of men engaged in research or development work Taylor (1958) constructed two equivalent forms of check-list scale for rating creativity in research or development work, as well as two equivalent forms for rating productivity. The rating is to be done by the immediate and secondary supervisors.

The American Institute for Research developed a test for selecting research personnel. This test consists of 150 items, each presented in multiple choice form with five alternatives. Each item presents a problem before a subject whose task is to select the alternative which best solves the problem. It has three subtests which require 65, 95 and 50 minutes respectively. The subtests are intended to predict chiefly job performances related to formulating problems and hypotheses and designing investigations, to predict behaviour related to conducting the investigation and interpreting research results, and to predict behaviours related to preparing reports, administering research projects and accepting organizational and personal responsibility. The nature of test items and the requirement of a minimum background of one year's college training in physics, chemistry and mathematics make this test an impractical one for use with students of intermediate classes.

Taylor (1950) also constructed a biographical questionnaire which contains 50 such questions as are often asked for selecting people for employment in research laboratories. Biographical inventories like the NASA Creative Key, Alpha Biographical Inventory and Biographical Inventory by Shaefer are very useful tools in identifying creativity in various areas of scientific research at the superior level.

The author thinks that science students of XI and XII classes cannot be considered as scientists. They appear to have quite different motivations and dedications. Further, the variables important for the

scientists or engineers may not be important for children studying science.

A significant amount of research has been done in developing tests for mathematical creativity. Prouse (1964), Meyer (1969) and Balka (1974) constructed tests to measure creative ability in Mathematics. Kapur (1978) suggested some problems for testing mathematical creativity. Brandwein (1955), Cohen (1975), and Majumdar (1974) developed tests to measure scientific creativity among students

Brandwein's (1955) four-year science training programme through which students are selected on the basis of the hypothesized (1) genetic (2) predisposing, and (3) activating factors is a superior operational system of selection This technique may be utilized through standardized project activities as the basis of selection of creative science students at the college level for higher education.

Majumdar (1974) developed a novel test to measure scientific creativity. He used a psychological construct based on 28SI-factors with contents from the areas of Physics, Chemistry, Biology and Mathematics The SI-factors were .

1. DFT	8 DMC	15. NMR	22. DMR
2. CMT	9. EMI	16. CSS	23. NMU
3. CMS	10 CFT	17. DMI	24 DSR
4. NMT	11. CMR	18. DMT	25 NMC
5. NST	12. CMI	19. CFS	26. MSI-NSI
6. CFI	13. DMU	20. NSR	27. DMS
7. NFT	14. EMR	21. CMV	28. DSU

This test appears to emphasize the importance of attempting to hurry creative effort by exercise of will. No doubt will and determination are necessary to establish the background and context of the problem. They are inimical to the effective functioning of the automatic, subconscious trial and error processes which are the only ones that can ultimately produce the discovery of the "clue" and the "insight". Golovin's (1963) remarks carry much weight in this regard He thinks : "Willful and conscious exploration of the associations of a particular pattern can be viewed as limited to neuron combinations that are immediately physically connected with it". It may thus lead to the detailed exploitation of only a small part of all the stored data patterns available in the cortex, and therefore to a decrease of the probability of locating suggestive patterns. We need tests which would be successful in inducing a general unconscious scanning of all the accessible possibilities. This calls for the use of open ended questions.

Cohen (1975) used Guilford's Utility Test as a model for the construction of the divergent instrument. The experimenter selected science concepts that had been introduced in kindergarten and broadened in subsequent years. The six concepts used were . magnet, animal, electricity, plant, lever, and air The corrected split-half reliability coefficient was 79 for the sixth graders and .83 for the seventh graders This test cannot be used with students in the high school or higher grades because of the apparent easy nature and irrelevance of its items for the purpose of discriminating highly creative science students from the less creative science students. Moreover, the items are of one type only. No elaborate scoring keys have been prepared by the experimenters.

Friedlander (1983) asked high school students to respond to a plant or animal stimulus through a series of divergent thinking questions dealing with data collection, problem solving, hypotheses construction and planning experiments. This test was used to measure students' scientific creativity.

The above mentioned review shows that the need for constructing a reliable as well as valid test to measure scientific creativity still exists In the pages to come I have described the method for constructing Tests of Scientific Creativity.

4.2. Selection of the Types of Test Items

First of all, items meant for measuring creativity (general) were examined. Their utility for measuring scientific creativity was visualized by the investigator and one to two sample-items were constructed in order to judge their suitability in local conditions Sample items represented the following tests ·

1 Redefinition
2 Figure Production
3. Planning Elaboration
4. Product Improvement
5. Guess Causes
6. Guess Consequences
7. Unusual Uses
8. Sensing Problems
9. Inquisitiveness
10. Block Design
11. Essay Writing

The sample items were discussed with the supervisor and two experts. As a result of discussions three tests viz. redefinition, planning elaboration, and essay writing tests, were dropped in view of their apparent difficulty level. Later on twenty carbon copies of the test were prepared,

and they were administered to twenty students studying in intermediate science classes. Five boys were studying in XI and five in XII class of Govt Inter College, Mainpuri Five girls were students of XI while the remaining five of XII class of Govt. Girls' Inter College, Mainpuri These schools were the average schools where pupils belonging to upper middle through lower class of the society go for schooling. The two schools were randomly selected from a total of three schools where Physics, Chemistry, and Biology subjects were being taught On the basis of students' responses it was finally decided to develop test items belonging to the following categories :

1 Consequences
2. Guess Causes
3. Unusual Uses
4. Inquisitiveness
5. Product Improvement
6 Block Design

4 3. Construction and Selection of Test Items for Various Tests of the Battery

After having decided the categories of tests, several items were written in several sittings. Whenever ideas about questions/items came to the mind of the present researcher, they were immediately noted The phenomena continued for days and months and resulted in construction of several items. The items were then written on separate sheets for various subtests. Seven items could be constructed for 'Product Improvement Test', eight items for 'Guess Causes Test', fifteen items for 'Consequences Test'; thirteen items for 'Unusual Uses Test', six items for 'Inquisitiveness Test', and ten triangular, ten cylindrical and twenty rectangular blocks with green, red, blue, black, white, yellow colours.

These items were discussed with eleven experts. As a result of discussions with them and in view of the anticipated difficulties to be expressed by the administrators, two items were selected for the 'Inquisitiveness Test', five items for the 'Guess Causes Test', thirteen items for the 'Consequences Test', three items for the 'Product Improvement Test', and all blocks for the 'Block Design Test'. These items except that of the 'Block Design Test' were got cyclostyled and administered to twenty students (10 boys and 10 girls) from Christian Inter College, Mainpuri and Govt Girls' Inter College, Mainpuri to conduct a preliminary try out study These institutions were of the average type

The frequencies of responses for particular test items were counted separately to find out the extent of its possible difficulty and variability which were employed as criteria for making the choice of items in

different tests of creativity. Those items which were not responded by more than five students or which failed in eliciting more different responses were dropped Thus five items were selected for inclusion in 'Consquences Test', four items for 'Unusual Uses Test', two items for 'Product Improvement Test', three items for 'Inquisitiveness Test', and four items for 'Guess Causes Test'. The 'Block Design Test' was retained as such. These items are as follows :

1. If legs of all honey bees of India are broken. (C. T.)
2 If there exists no carbon-di-oxide gas in the environment of earth. (C. T)
3 If horses start living on trees. (C. T)
4. If lions become immortal. (C. T.)
5. If wings are transplanted to human body (C T.)
6. Beaker (U. U. T.)
7. Wax (U U T)
8 Water (U. U. T)
9. Needle (U. U. T.)
10 Model Showing Reflex Action (P. I. T.)
11. Model of Parrot (P I T)

12 & 13. two experimental settings (designed by the present researcher to demonstrate discovery learning to his colleagues in 1979) (I. T.),

14. An abnormal mammal with face like a man (I. T.)
15. Reasons for the external structures as visible in the abnormal man (G. C. T.)
16. What will be the causes for the survival of the abnormal man when he does not die even after inhaling a capsule containing mixture of poisonous substances like Copper Sulphate, acid and Arsenic etc. (G. C. T.)
17. Difference in the presence of granular structures in two settings of fig I (meant for 12 & 13 items).
18. Causes for the death of larva present on a leaf (shown in a figure)
19 Block Design Test

In view of the difficulties expresed by try-out sample subjects detailed instructions were prepared and examples were given for each test except the 'Guess Causes Test'. This preliminary form of the test was got printed and used with the item-analysis sample subjects. This test was administered to 74 students studying Biology in intermediate (XI &XII) classes in six schools.

Time limits were set and they were strictly observed. Time limit for each of the items at number 1-9 and 15-18 was three minutes For each of the 10-14 items it was six minutes Students were given ten minutes to respond to the Block Design Test The author noted as well as explained the difficulties expressed by the students All tests except the Block Design Test which was administered individually, were administered to groups Careful supervision was done to avoid copying of other student's responses. No student was allowed to write after the expiry of the scheduled time limits

4 4 Item Analysis

Item analysis is one of the important and essential steps in the development of psychological tests. Gulliksen (1950), Guilford (1954), and Garrett (1959) have favoured employing item analysis for improving the reliability and validity of tests. Item analysis primarily concerns with item difficulty and item discrimination Item difficulty is taken in terms of the proportion of individuals completing the item successfully and item discrimination index refers to the degree to which it differentiates between those obtaining high scores and those obtaining low scores on the test. However, in the development of the present test of scientific creativity item difficulty could not be determined in the conventional way because the items in the tests of scientific creativity demanded responses of divergent nature Discrimination value for each item has been calculated in terms of t-ratio by taking upper and lower twenty seven percent cases of the sample

4. 4 1. *Construction of Scoring Keys*

First of all, responses of 74 students to various items of the test were written. Then, responses to each item were classified in several categories The lists of responses with the categories to which they belong were examined many a time by the author They were also discussed with five research workers in the field of science (Physics, Chemistry, Zoology, and Botany), and two science teachers The overlapping categories were reclassified and finally 9 to 32 categories were assigned to the responses given by 74 subjects.

Then, originality weights were calculated for every item For this, frequencies pertaining to appearance of a particular response were found out. They were classified on a five-point scale. The originality weights for various items were determined with the help of following table :

Table 4 1 *Showing frequencies for a response on a test item and the originality score to be assigned to it*

Frequency in percentage	Originality score
1	4
2	3
3	2
4	1
5	0

The categories to which various responses belong and the weight age given to them with respect to their originality are as follows

ITEM (1) *If legs of all honey bees of India are broken,*

Categories

A Locomotion
B Feeding habits
C. Studies
D Physiology of plants and reproduction
E Ecological niche
F. Atmosphere
G Industries
H. Taxonomy
I. Adaptation, evolution and Genetics
J. Animal physiology and reproduction
K. Survival of population
L. Human life
M. Morphology of plants
N Animal care
O Ecosystem and food chain

Responses

Inability of bees to fly (A, O) ; difficulty in flying (A, O), trouble in sitting (A, O) , inconvenience in moving from one place to the other (A, O) , inability of bees to sit on flowers (A, O) , immobile bees (A, O) , inability to move from one flower to another one (A, O) , difficulty in travelling from one flower to another (A, 4) ; disturbed equilibrium during flight (A, 4) , no sucking of nectar from flower (B, O) , nonavailability of food to bees (B, 1) ; no formation of honey (B, O) , inconvenience in carrying nectar

from flowers (B, O) ; bee's inability to collect nectar (B, O); nonavailability of food for organisms (B, 4) , students' inability to study legs of honey bees (C, O) , student's inability to study bees (C, 3) , no fertilization in flowers (D, 2) , hindrance in entomophily (D, O) , no entomophily (D, O) , less contribution of bee insects in pollination (D, O) , no cross pollination in some flowers (D, O) ; less cross pollination in flower (D, O) , no formation of honey combs (E, O) , permanent living on one flower (E, 4) , lack of oxygen (F, 4) , decrease in the production of things made from honey combs (G, 4) , less production of wax (G, 4) , no existence of wax related industries in India (G, O) , no production of natural wax (G, 2) , loss to medicine industries (G, O) , no business of producing honey (G, O) , exclusion of bees from class Insecta (H, 4) ; a different zoological name for honey bee (H, 4) , a different classification (H, 4) , adaptation to live without legs (I, 4) ; less development of bees deprived of legs (I, O) , no inheritance of acquired characters (I, 1) ; origin of legless bees (I, 4) , no legs in bess of next generation (I, 2) ; origin of a new species (I, 4) , trouble in reproduction (J, 2) , no reproduction in bees (J, 2) , less growth of bees (J, 4), inconvenience in laying eggs (J, 3) , death of honey bees (K, O) , decrease in the population of honey bees (K, O) ; extinction of the species (K, O) , no increase in the population of bees (K, O) , gradual decrease in population (K, 3) , decrease in plant population (K, 3) , difficult for bees to survive (K, 4) , nonavailability of honey (L, O) , less quantity of available honey (L, O) , nonavailability of wax (L, 2) ; difficulty in Ayurvedic treatment of diseases (L, 2) , nonavailability of medicines prepared from honey (L, 4) , no cure of diseases (L, 4) , damage to crops (L, 4) , spreading of diseases (L, 4) , difficulty in collecting food (L, 2) , difficulty in maintaining the health of the body (L, O) , use of saturated sugar solution in place of honey (L, 4) , increase in occurrence of diabetic patients (L, 4) , less quantity of available wax (L, O) , adverse effects on human physiology (L, O) , difficulty in taking some medicines (L, 4) , occurrence of more diseases (L, 4) , difficulty in getting honey (L, 2) , decrease in number of flowers (M, 4) ; nonavailability of fruits of some species (M, 2) , nonavailability of flowers of some species (M, 4) , increase in the quantity of nectar in flowers (M, 4) , less number of flowers which depend on insects for pollination (M, 4) ; less number of fruits (M, 2) ; no bee keeping.(N, 4) , more apiculture (N, 4) , death of insects depending upon bees for their nutrition (O, 3) , disturbed ecological equilibrium (O, 2) , scarcity of food for herbivores (O, 4) , scarcity of food for human beings (O, 3) , scarcity of food for carnivores (O, 4) , devouring of weaker bees by the stronger ones (O, 4)

ITEM (2) *If there exists no carbon-di-oxide gas in the environment of earth,*

Categories

- A Survival of organisms and ecosystem
- B Morphology of organisms
- C Physiology of organisms
- D Feeding habits of organisms
- E Evolution
- G. Ecological niche
- H. Soil erosion
- I Atmosphere
- J Study
- K Industry
- L Economy
- M Transport

Responses .

Death of organisms (A, O) ; decrease in the population of animals (A, O) , decrease in the population of plants (A, 2) . destruction of autophytes (A, O) , impossible for organisms to live on earth (A, O) ; inability of trees to live (A, O) ; inability of man to live (A, O) , miserable life of human beings (A, O) ; animal's life full of dangers (A, O) . death of plants (A, O) , destruction of crops (A, 3) , death of lower plants like algae (A, 4) , death of human beings (A, O) , death of herbivores (A, O) , decrease in the population of herbivores (A, 4) , destruction of plants (A, O) , decreased dependence of animals on plants (A, 4) , no herbivorous animal on the earth (A, 2) , adverse effects on biotic factors (A, 2) , no aquatic plants (A, 4) , disturbed ecosystem (A, O) , broken plants (B, 4) ; yellow plants (B, 4) , no cotton fibres (B, 4) , less weight of plants (B, 4) , dry plants (B, O) , no fruits (B, 3) , no flowers (B, 4) ; many adaptations in human body (B, 4) ; no respiration (C, O) , hindrance in the growth of plants (C, 4) , no photosynthesis (C, O) , no oxygen to man for respiration (C, 2) , inability of plants to respire at night (C, 4) , no growth in many plants (C, 3) , stopped physiological activities of many plants (C, O) , difficulty in inspiration or expiration (C, 4) , no production of fruits (C, 3) , no oxygenation of blood (C, 2) , retarded rate of other activities of life (C, 4) ; no resistance (C, 4) ; no transpiration (C, 3) ; no excretion of carbon-di-oxide (C, 4) , no use of solar energy by plants (C, 4) , no development of herbivores (C, 4) , no development of carnivores (C, 4) , no production of Oxygen (C, O) ; no oxidation of food (C, 4) , hindrance in respiration (C, O) ; ease in breathing (C, 4) , no occurrence of diseases caused by carbon-di-oxide (C, O) , suffocation from breathing (C, 3) ,

decrease in the rate of photosynthesis (C, 4), absence of a most important gas for plants (C, O), deficiency of nutrients in plants (C, 4), no absorption of water from the soil (C, 4), adverse effects on plant life (C, 3), occurrence of more diseases in the human beings (C, 4), inability of plants to take carbon-di-oxide (C, O), fading of plants (C, 1), nonavailability of food to plants (D, 4), nonavailability of food to animals (D, 4), plants to become parasites (D, 4), no food to plants (D, O), deficiency of animal food (D, 4), no food for man (D, O); food problem on the earth (D, O); all men to become carnivores (D, 4); nonavailability of food to herbivores (D, 4); finishing of a source of human food (D, 4), fear of extinction of human species (E, 2), herbivores to become carnivores (E, 4); gradual disappearance of plants (E, O), gradual disappearance of organisms (E, 1), extinction of plant species (E, O), evolution of a man who will not need food and carbon-di-oxide (E, 4), evolution of plants who will use oxygen instead of carbon-di-oxide (E, 4), extinction of consumer organisms (E, O); extinction of carnivores (E, 4), no animal life on earth (G, O), earth like a barren desert (G, O), no forests (G, 4), no plant life on earth (G, O); no plants for birds to perch at (G, 4); earth surface flooded with water (G, 4); occurrence of soil erosion (H, 4), less pollution (I, O), increase in per-cent quantity of gases in air (I, O), more quantity of oxygen (I, O), solving of the problem of pollution (I, 3), non-availability of oxygen for many works (I, 4), consumption of all oxygen (I, 4); deficiency of carbon (I, 4), no formation of carbon compounds (I, 4), difficulty in extinguishing fire on the earth (I, O), adverse effects on the atmosphere (I, 1); lack of oxygen (I, O); pollution in atmosphere (I, O), planet like earth (I, 4); no burning of wood, etc (I, 4), change in O_2/CO_2 ratio (I, 4), change in the weight of air (I, 2), rapid rate of combustion (I, O), nonavailability of plants/flowers for study (J, 4), no formation of carbides (J, 4), no work in laboratories (J, 4), no use of carbon (J, 4), inability to test carbonate (J, 4), difficulty in preparing carbon compounds (J, 2), impossible to study uses/properties of corbon-di-oxide (J, O), no oxidation of glucose (J, 4), nonavailability of carbonic gases (J, 4), no carbonic acids (J, 4); less chemical reactions for students (J, 2), inability to use carbon-di-oxide in the laboratory (J, 1), lack of carbonic compounds (J, 3), impossible to prepare carbon-di-oxide gas in the laboratory (J, 4), demonstration of the violation of law of conservation of mass when oxidation of compounds will occur (J, 4), no extraction of metals (J, 4), no paper industry (K, O); no cotton industry (K, 4), less number of industries demanding the use of flowers (K, 4), disappearance of many industries (K, 1), no timber industry (K, 3); establishing many industries to obtain adequate carbon-di-oxide for plants (K, 4), no apiculture (K, 4), no pro-

duction of lac (K, 4) ; no production of silk (K, 4) , less quantity of cereals (L, 3) , decrease in the quantity of medicines (L, 4) , nonavailability of rubber (L, 4) , burning of the world (L, 4) , easy burning of various things (L, O) , shortage of clothes (L, 4) , more consumption of fuel (L, O) , shortage of fuel (L, 3) , nonavailability of useful plant products (L, 3) , adverse effect on means of transport (M, 4)

ITEM (3) · *If horses start living on trees,*

Categories

A Studies
B Taxonomy
C Locomotion
D Feeding habits
E Physiology of horse
F Morphology of horse
G Physiology of plants
H. Morphology of plants
I Anatomy of horse
J Ecological niche
K Ecosystem and food chain
L Effect on other animals
M Survival of population
N. Evolution
O Industries
P Economy
Q Transport

Responses

Inability of students to obtain first hand knowledge of the structure of a typical horse (A, O) , change in the characteristics of horse (B, 4) , progressive decrease in capacity to run (C, O) , less walking (C, O) , difficulty in climbing trees (C, O) , trouble in getting down from the trees (C, O) , lessening of the speed of running (C, O) , learning to jump from one branch to another (C, 4) , inability to run on the branches of trees (C, O) , inability to climb trees (C, O) , inability to sit on the branches of tree (C, O) , start eating leaves (D, O) , nonavailability of food to organisms (D, 1) , horses to become herbivores (D, O) , nonavailability of fruits to man for eating (D, 3) , trouble to horse in taking its food (D, O) , inability of

horse to drink water (D, O) ; eating of all the fruits by the horses (D, O) ; less quantity of available food (D, O) , spoiling of fruits (D, O) ; eating of plant leaves (D, O) ; no grazing by the horses (D, O) ; change in food habits of the horse (D, 3) , limited food for the horses (D, O) ; eating of grass (D, 4) ; difficulty in nutrition (D, 4) ; effect on all the activities of life (E, O) , effect on respiration (E, 4) ; no respiration (E, 4) , ill health of the horses (E, 4) , malnutrition (E, 4) , rare reproduction (E, 4) , problem in sleeping (E, 4) , making proper arrangements for reproduction (E, 4) , change of colour (F, 2) , change of form (F, 2) ; changes in leg of horses (F, 4), adaptations to climb easily on trees (F, 4) , adaptations to live on trees (F, 3) , developed sensory organs (F, 4); adaptations to feed on arboreal things and organisms (F, 4) ; changes in the structure (F, 4) , drying of plants (G, 2) , no green plants (G, O) ; availability of inadequate light to plants (G, 4) , no photosynthesis (G, O) ; difficulty in manufacturing food (G, 4) ; inability of plants to grow rapidly (G, 4) , no complete development (G, 4) ; rapid development of plants (G, 4) , no respiration (G, 3) , breaking of plants (H, O) ; nonavailability of fruits (H, 4) , decrease in the number of leaves (H, 4) , no leaves (H, 3) , no fruits (H, 2) , less number of fruits (H, 1) , less developed muscles (I, 4), effect on internal organs (I, 4) , no space for birds to live (J, 1) , planting of trees by those who domesticate horses (J, O) , presence of no organism except horse on plants (J, O) ; arboreal nature (J, O) ; destruction of homes of arboreal animals (J, 4) , difficult for birds to live on trees (J, O) , unbalanced ecosystem (K, 3) , death of herbivores (K, 2) ; falling down of trees (K, O) , no life on the earth (M, 3) , destruction of plants (M, O) , no life of human beings (M, 4) , death of horses (M, 3) ; decrease in the number of plants (M, O) , decrease in the number of horses (M, 2) , decrease in the population of birds (M, 4) , destruction of weak trees (M, 4) , vanishing of small trees (M, 4) , threat to the survival of horses (M, O) , reduction of body weight (N, O) , heavy trees (N, 4) , flexible trees (N, 3) , shortening of the body (N, 2) , less development of horse's legs (N, 3) , next generation horses to reside on the trees (N, 4) , gradual diasppearance of legs (N, 4) , small legs (N, 3) , origin of fingers in foot (N, 4) , gradual decrease in the number of horses (N, 4) , next generation to be terrestrial (N, 4) , broader and stronger stems of trees (N, 3) , extinction of species of plants which are constantly inhabited by the horses (N, 4) , origin of a new species (N, 4) , gradual reduction of size (N, 4) , reduction in the weight of the skeleton (N, 4) , development of a prehensile tail (N, 4) , shortening of neck (N, 3) ; evolution of wings for flight (N, 4) , adverse effects on furniture industry (O, 4) , adverse effects on fruit business (O, 4) , difficulty in cutting wood (P, 3) , less fuel to burn for domestic use (P, 2) , death of wood (P, 4) ; no benefit

from the horses (P, 1), inability of human beings to compel horses to work (P, 4); damage to tree-property of the country (P, 4), difficulty in riding (Q, O), no use of horses for carrying load (Q, 1), disappearance of vehicles which need horses (Q, 1), less number of 'Tanga' (Q, O), unsuitability of horses for riding (Q, 2), impossible movement from one place to another (Q, O); no use of 'Ekka' or 'Tanga' (Q, O); less use of horse in transport (Q, O), no use of horse in transport (Q, 4).

ITEM (4) · *If lions become immortal,*

Responses to this item were not classified and no effort was made to determine originality weights for various responses

ITEM (5) *If wings are transplanted to human body,*

Categories

A. Scientific study
B. Taxonomy
C. Parental care
D Locomotion
E. Feeding habits
F Physiology of man
I Physiology of plants
K Morphology of plants
L Ecological niche
M Survival of population, ecosystem and food chain
N Environment and its effects
O Effect on other animals
Q Evolution
R. Affinities with other animals
S Industries
T Economy
U Transport

Responses

More dissemination of scientific knowledge (A,3), discovery of vehicles which can fly (A, 4), new discoveries (A, O), acquisition of complete knowledge about wings (A, O), no felt need for research to improve means for transport (A, 4), no advances in aeronotics (A, 4), development of ability to survey all places (A, O); knowledge about planets (A, 4); no aeronotical engineering (A, 4), more knowledge of space life (A, 3); more knowledge about various environments (A, 3), change of class to which human beings

belong (B, 3), serve as a connecting link between mammals and aves (B, 4), disappearance of distinguishing characteristics of mammals (B, 4); difficulty in identification of man (B, O), inclusion of the man in class 'Aves' (B, O); difficulty in rearing children in the rainy season (C, 4), ease in moving from one place to another (D, O), start flying (D, O), make efforts to fly (D, O), ease in reaching the moon (D, 1), development of the capacity to visit distant places (D, O): ease in reaching the trees (D, 4), ease in reaching the Mars (D, 2), ease in reaching the Venus (D, 3), ease in reaching the Sun (D, 4), no stay at one place (D, 3), start sitting on/trees (D, 4); no less walking (D, O), ease in reaching the desired places (D, O); convenience in reaching other planets (D, 1), start travelling in space (D, 3), no difficulty in crossing over geographical barriers (D, 4), fly in the sky (D, O), learn how to fly (D, 4), frequent occurrence of collisions (D, 3), climbing of mountain in no time (D, 4), inconvenience in flying (D, O), ease in reaching highest places (D, O), less number of accidents (D, 2), eat fruits borne on trees (E, 4), availability of less quantity of food (E, 4), ease in killing birds (E, 3), difficulty in caring for food (E, 4), using flight to search food (E, 4), ease in collecting animals for their food (E, 4), less difficulty for food (E, 4), food problem (E, O), immediate capturing of aves (E, 3), change in nutrition habits (E, 3); difficulty in inhaling food (E, 4), inactive men (F, 2), no feeling of fatigue (F, 3), inconvenience in breathing (F, 4), different mode of respiration at high altitudes (F, 4), all physiological activities in air (F, 3), difficulty in performing various life activities (F, O), improper digestion of food (F, 4); changes in physiological activities (F, 4), defective coordination of various activities (F, 3); less number of diseases (F, 3), changes in reproduction (F, 4), less production of crops (I, 4), breaking of plants (K, 4), plucking of flowers or fruits (K, O), no human life on the ground (L, 2); no life on earth (L, 4), no need to construct houses (L, 4), arboreal men (L, 2), no desire to live on earth surface (L, O), no space for the aves to live in the sky(L, 2), crowded sky (L, O), gregarious habit of living (L, 3), no problem of space to live in (L, O), men will reside in the space (L, O); men will reside in the space as well as on the earth (L, O), less human population on earth (L, O), frequent migration like birds (L, 4); early death of man (M, 4), less number of deaths in road accidents (M, 4), more dangers to man, (M, 4), killing of birds (M, 3), man will start devouring all animals (M, 4), man will start destroying vegetation (M, 4), disturbed ecosystem (M, 3); adverse effects on food chain (M, 4), more plants on the surface of the earth (M, 4), less effect of air pollution on man (N, 4); no need of warm cloths in winter (N, 4); protection from harmful waves (N, 4), protection from electro-magnetic waves (N, 4), protection from accidents

(N, 4) ; pollution of atmosphere (N, 4) , man will be a popular source for artificial dispersal of seeds and fruits (N, 4) ; more harm from solar radiations (N, 4) , defensive adaptations in insects to ensure safety from human beings (O, 4) ; adaptation in birds to save themselves from men (O, 4) ; troublesome life of insects (O, 4) ; troublesome life of all arboreal animals (O, 4) ; increase in the population of pests (O, 4) , no space for birds to lay their eggs (O, 4) ; ease in capturing birds (O, 3) , troublesome life of all organisms in the atmosphere (O, 3) ; increase in the difficulties of birds (O, 2) ; decrease in the avian population (O, O) ; ease in killing organisms (for men) (O, 4) ; easy for children to catch butterflies (O, 4) , less use of legs (Q, 4) ; weakening of legs (Q, O) ; tree will tolerate excessive weight of human beings (Q, 3) , modification in the shape of the body (Q, 2) , lessening of the body weight (Q, O) , presenee of wings in the children of next generation (Q, 3) , gradual extinction of avian species (Q, 4) , extinction of *Homo sapiens* (Q, 4) ; more hairs on the body (Q, 4) , loss of legs (Q, 4) , adaptation for aerial life (Q, 4) ; no development of legs (Q, 3) ; disappearance of wings (Q, 4) , shortening of the body (Q, 3) , inactivation of muscles in legs (Q, 3) ; shortening of hands (Q, 3) . shortening of human legs (Q, 3) , no use of hands (Q, 3) , increase in the diameter of chest (Q, 4) ; increased eye sight (Q, 4) ; danger for the existence of leaves, (Q, 4) ; disappearance of human hands (Q, 2) , no development of muscles of hand (Q, 4) ; disappearance of useless organs (Q, 4) , presence of useless organs as vestigial organs (Q, 3) , more development of brain (Q, 4) ; more development of cerebellum (Q, 4) , development of the capacity to fly (Q, O) ; no felt need of legs (Q, 4), weakening of feet (Q, 4) ; useless legs (Q, 4) , loss of urinary bladder (Q, 4) , development of flight muscles (Q, 4) ; weakening of body (Q, 4) , weakening of legs (Q, 4) ; changes in external structures (Q, O) ; modification of body shape for flight (Q, O) ; pneumatic bones (Q, O) , no placenta during development of babies (Q, 4) , laying of eggs by men (Q, 4) ; birds and human beings to live together (R, 3) , occurrence of body changes like birds (R, O) , bird like voice (R, 4) ; making birds-like nests (R, 4) ; bird-like walking (R, 4) ; bird like habits (R, 4) , bird like flight (R, O) , possess characteristics of mammals and birds (R, 4) ; no factories to manufacture means for transport (S, 3) , no factories to manufacture aeroplanes (S, 4) , no telephones (S, 4) ; adverse effects on automobile industry (S, 4) , economy of petrol (T, 3) ; economy of coal (T, 4) , economy of diesel (T, 4) ; no petrol crisis (T, 4) , solving of energy crisis by man (T, 4) , saving of money spent in transports (T, O) ; solution of the fuel problem (T, O) ; no need of means for transport (U, O) , no existence of a means for transport (U, 3) , lesser use of aeroplanes (U, 2) , no transport (U, O) ;

no need of aeroplanes (U, 1) ; useless aeroplanes (U, 2) ; all means for transport to become useless (U, O) ; less need of aeroplanes (U, 3) ; no existence of aeroplanes (U, 4) ; less need of vehicles (U, 1) ; decrease in number of means for transport (U, 4) ; no need of cars (U, 4) , no need of rikshaw (U, 4) , no use of helicopters (U, 4) ; no use of cycles (U, 4) ; no use of scooters (U, O) ; no use of cars (U, O) , no use of trains (U, O) , no use of buses (U, O) , no problem of transport (U, 4) ; man to serve as a new means of transport (U, 4)

ITEM (6) *Beaker,*

Categories ·

A For measurement

B For optical experiments

C In pressure based experiments

D In boiling or cooling substances

E. In electricity based experiments

F To replace other instruments or apparatus

G As a container

H In physiological experiments

I In dissections

J In morphological studies

K In transfer of substances

L In gaining knowledge about physical properties

M In the preparation of solutions

N In chemical analysis

O In the preparation of substances

P In making models

Q In construction of apparatus, etc

R In density based experiments

S In sound based experiments

Responses ·

To measure liquids (A, O) ; to find out diameter of beaker with the help of vernier (A, O) , to find out the depth of beaker with the help of vernier (A, O) ; to know the quantity of a substance (A, 4) ; to find out the width of glass with the help of screw guage (A, 1) , to find out its curvature with the help of spherometer (A, 4) ; in doing experiments concerned with refraction (B, 4) ; in finding out refractive index of water (B, 3) , in finding out the refractive index of glass (B, 3) ; in the demons-

tration of refraction (B, 3) ; in finding out the refractive index of water etc. with the help of travelling microsope (B, O) , in finding out the refractive index of a liquid (B, O) ; in the demonstration of tyndall effect (B, 4) , to perform experiments concerned with light (B, 4) ; to let pupils experience atmospheric resistance (C, 4) , to create centrifugal force (C, 4) ; in measuring pressure (C, 4) , in the verification of Pascal's law (C, 4) ; in heating up a liquid (D, O) , in providing heat to substances (D, O) , in boiling liquids (D, 2) : in boilng organic liquids (D, 4) , as a water-bath (D, 4) ; in making cells (E, 3) , in electric circuits (E, 4) ; in electrolysis (E, 1) ; in electroplating (E, 4) ; in place of measuring cylinder (F, 4) , in place of test-tube (F, O) , to replace a bottle (F, 2) , to replace tank in an aquarium (F, 4) , in place of flask (F, O) ; to replace gas jar (F, 4) , in planting (G, O) , in the watering of plants (G, 3) ; to keep plants in it (G, O) , in preserving animals (G, 4), in keeping sprit or alcohol in it (G, O) ; in containing medicines (G, 4) , in storing piths (G, 4) , in keeping fungi (G, 4) , in keeping unicellular animals (G, 4) , in keeping algae (G, 4) , in keeping *Amoeba, Paramecium* (G, O) , in keeping multicellular animals (G, 4) , in keeping vegetation (G, 3) , in keeping typical representative organisms (G, 3) , in containing soil (G, 4) , in collecting frogs (G, 4) , in the collection of scorpions (G, 4) ; in keeping water in it (G, O) , in keeping chemical substances (G, O) , in keeping acids (G, O) , in keeping alkali (G, 3) ; in containing waste products produced during some experiments (G, 4) ; as a container (G, O) , in giving medicines to patients (G, 4) , in keeping a substance (G, O) , in storing water (G, O) ; in keeping chloroform (G, 4) ; in keeping chemical compounds (G, 2) , in keeping liquids (G, O) . in keeping solutions (G, O) , in collecting flowers of various types (G, 4) , in keeping gas (G, O) , in keeping fishes (G, 4) , in keeping sections (G, 4) , in keeping test tubes in it (G, 4) ; in keeping funnel (G, 4) , in determining whether oxygen is produced during photosynthesis (G, O) , in the culture of various animals (G, 4) ; in the artificial development of plants (G, 4) , in clotting of blood (G, 4) ; in the germination of seeds (G, 3) ; in the experiment to show plasmolysis (G, 4) ; to demonstrate osmosis (G, 1) ; to demonstrate respiration in plants (G, 4) , to demonstrate suction pressure (G, 4) ; to perform an experiment to show transpiration (G, 2) , to show root pressure (G, 4) ; to observe metamorphosis in animals (G, 4) , to observe reproduction in an animal (G, 4) ; to find out the rate of growth in a plant (G, 1) ; to demonstrate liberation of carbon-di-oxide during respiration (G, 4) , to perform iodine test for starch (G, 4) , to demonstrate conditions necessary for the germination of seeds (G, 4) , to establish the need of oxygen for respiration (G, 4) , to study germination (G, 3) , in washing frog etc. (I, 3) ; to keep water during dissection (G, 1) , to make a frog unconscious by keeping it in

a beaker containing chloroform (G, 3), to study the morphology of plants (J, 3), to show living animals (J, 4), in the transfer of substances (K, O), in pouring liquids (K, O), in the transfer of acids or alkali from one vessel to the other (K, O), in gaining knowledge about the colour of a solution (L, O); to know physical properties of something (L, 1), in seeing migration of ions (L, 4); to make solutions of chemical substances (M, O), in filtration (M, O), in the preparation of mixtures (M, O); in dissolving a precipitate (M, O), in titration (N, O), in the chemical analysis of a mixture (N, O); in finding out the normality or viscosity of a liquid (N, 4); to find out the melting point (N, 4); to find out the equivalent weight (N, 4), to know solubility of a substance (N, 4); to determine boiling point of a liquid (N, 4); to test urine (N, 4), to study the properties of a gas (N, 4); in precipitation (N, 4), in testing acid or alkali (N, 4), in the removal of interfering radicals (N, 4), in the preparation of gases (O, O); in collecting a gas (O, O), in the preparation of chemical compounds (O, O); in cooling a substance (D, 4), in heating chemicals (O, 3), in the preparation of Sodium Carbonate-Extract (O, 4), in preparing Sodium-Extract (O, O), in diluting a definite quantity of acid (O, 1); in enlarging a crystal (O, 4); in making chemical gardens (O, 4), in making pastes (O, 4), in removing impurities (O, 3), in the distillation of water (O, 4), in making a solution concentrated (O, 4), in passing some gas into a solution (O, 1); in the preparation of aquaregia (O, 1); in the purification of substances (O, 4); in making models (P, 1), in making thermometer (Q, 3); in making Lechlanche Cell (Q, 4), in making an aquarium (Q, 4); in the verification of Archemediz principle (R, O), in finding out the density of a substance (R, 4); in finding out the volume (R, O); in determining the relative density (R, O), in experiments to show resonance (S, O)

ITEM (7) *Wax*,

Categories .

A. In Organic Chemistry

B In preparation of substances

C. In making apparatus air tight

D In demonstrating a phenomena

E In optical experiments

F In protection and preservation

G In heat experiments

H For closing holes

I. For replacing certain substances and apparatus

J. For making models

K. In dissections

L In construction of apparatus

M In testing hypotheses

N As a fixer

Responses

In medicines (A, O), in organic chemistry (A, O), in getting carbon from wax smoke (B, 4); in making colours (B, O), in burning (B, O), in making candles (B, O); in making points on something (B, 4), in making wax rods (B, 4), in closing the mouth of an air-tight tube (C 3), for making apparatus air-tight (C, 1), on the mouth of collection tubes or jars (C, 4); for making bottles water-proof (C, 4), in apparatus for making oxygen gas (C, O), in demonstrating physical change (D, 4), in demonstrating chemical change (D, 4), in providing additional strength to a thread (D, 1), in finding out the resolving power of a lens (E, 4); in obtaining light (E, O), in preserving materials for a long time (F, 2); for safety (F, 4), in rubbing over something (F, O), for keeping marks protected from the effects of water (F, 3), for touching electrical appliances (F, 4), in keeping paper free from the effects of water (F, 2), in finding out the effect of heat (G, 4); to prove laws of cooling (G, 4); in closing holes in a ship (H, 4), for closing holes (H, 2), in place of spirit lamp (I, 4), for pasting (I, O); in place of cork for closing bottles (I, 4), in replacing glass (I, 4), in place of weight in some experiments (I, 4), in making models (J, O), in making blocks (J, 2), for carving (J, 4); in making various designs (J, 3), in obtaining impressions of solid things (J, 3), in making artificial hands (L, 4), in making artificial legs (L, 4), in embalming (J, 3), in testing effects of no cutaneous respiration (M, 4), in coating skeleton (M, 4), in coating oesophagus (M, 4), in making temporary joints (N, 4), in fixing broken material (N, 2), in making wax pencils (I, 4), in making models of machines (J, 4), in making records (I, 3), in making paper weights (J, 3); in sealing bottles (H, 3).

ITEM (8) *Water*,

Categories

A In preparation of solutions

B In electrolytic dissociation

C In preparation of substances

D In chemical analysis

F. In finding out the freezing point
G. In finding out the melting point
H In purification
I In demonstration
J In producing pressure
K. In replacing substances
L In checking solubility of substances
M In electricity based experiments
N For optical use
O For finding out the density
P In securing energy
Q For controlling temperature
R In heat based experiments
S In sound based experiments
T In making models
U In making apparatus
V For observing organisms
W. For washing
X In physiology of plants, animals, etc organisms
Y For rearing of organisms
Z In dissection of organisms

Responses

In diluting acids (A, 1) , in preparing alkali (A, 4) , as a solvent for inorganic compounds (A, 3) , in making solutions (A, O) , in making mixtures (A, 4) , in decreasing the concentration of a liquid (A, O) , as a solvent (A, 3) , in dissolving solids (A, 4) , in electrolytic dissociation (B, O) , in the preparation of gases (C, 2) , in collecting gases (C, 3) , in making injections of distilled water (C, 2) , in obtaining hydrogen gas (C, 2) , in obtaining oxygen gas (C, O) , in making ice (C, 2) , in making steam (C, 3) , in making medicines (C, 4) , in chemical reactions (D, 4) , in cleaning test tubes (D, 3) , in testing of salts (D, 4) , in cleaning laboratory apparatuses (D, 3) , in chemical anaylsis (D, 3) , in preparing acids (A, 3) , in finding out the melting point (G, 4) , in finding out the freezing point (F, 4) , in obtaining pure water (H, 3) , in showing properties of liquids (I, 4) ; in demonstrating refraction (I, 3) ; for finding out whether two points are at the same level (I, 4) , in showing the process of absorption of water by plants (I, 3) , to produce hydraulic pressure (J, 3) , as a mirror (K, 4) , in place of petrol in vehicles (K, 3) ; for checking solubility of substances (L, 4) , for generating electricity (M, O) ; in finding out

refractive index (N, 1) ; in finding out relative density (O, 3) , in finding out density of a substance (O, 4) , in obtaining energy (P, 4) , in cooling an engine (Q, 4) , for cooling things (Q, 3) , in finding out latent heat (R, 4) , for increasing the length of metals (R, 4) , in finding out the co-efficient of linear expansion (R, 4) , in finding out the specific heat of a substance (R, 4) , in finding out the frequency of a tuning fork (S, 4) , for obtaining solid bottle shape ice (T, 4) , for constructing hydro-operated jets (U, 4) , for studying aquatic animals (V, 4) ; for studying aquatic plants (V, 4) , in preparation of food by plants (X, 1) , for washing slides (W, 4) ; for washing the unwanted soil away (W, 4) , for washing objects (W, O) , for washing various apparatus (W, 1) , for drinking water by organisms (X, 4) ; for respiration (X, 3) , in germination of seeds (X, 4) ; in the growth of plants (X, 3) in experiments concerned with photosynthesis (X, 4) , in transpiration (X, 1) , in various life activities of plants (X, 4) , for irrigation (X, O) , for keeping fishes alive (X, 4) ; for respiration in aquatic animals (X, 3) , in digestion of food (X, 2) ; for the life of human beings (X, O) , for the life of aquatic plants (X, 4) ; for the life of terrestrial animals (X, 2) ; for the life of organisms (X, O) , for photosynthesis (X, O) , in experiments pertaining to respiration (X, 4) ; in inhaling medicines (Y, 4) , in gardening (Y, 3) , in rearing fishes (Y, 4) , in tray while dissecting frog etc (Z, 4) , in dissecting frog (Z, 4) , in dissecting earthworm (Z, 4) , in dissectng animals (Z, 4)

ITEM (9) *Needle,*

Categories .

A. Measurement
B Chemical analysis
C. Preparation of solutions
D. Attaching two things
E Replace something
F Optical experiments
G Magnetism experiments
H Removal of dust
I Sound experiments
J. Collection of organisms, etc
K Obtaining crystals
L. Demonstrations
M As conductors of heat and electricity
N Dissection of animals

O. Puncturing and protection
P. Animal behaviours
Q. Teasing tissues
R. Physiological experiments
S. Making instruments or apparatus
T. Making slides
U. Making models
V. Density experiments

Responses :

In finding out diameter with the help of screw guage (A, O), in balancing the physical or chemical balance (A, J); in flame test (B, O); in Borax-Bead test (B, O); in dissolving solutes (C, 4); in keeping two things combined together (D, 4), in keeping broken limbs near each other (D, 4), in place of pin in optical experiments (E, 2); as board pin (E, 2), in place of weights in various experiments (E, 4); in place of nails for hanging a pendulum (E. 4); in place of pin (E, O); as a pendulum (E, 4); as pointer (E, 2); in knowing the height of solution in a vessel (A, 4); as a stirrer (E, 4); in place of needle (E. O), as a tooth prick (E, 4), in obtaining crystals (K, 2); in finding out the focal length of a lens (F, O); in finding out the refractive index of water (F, 2), in finding out the refractive index of glass (F, 2), to determine focus of mirror (E, 2), in making various types of images (F, 3); in performing optical experiments (F, O); in finding out the refractive index of any liquid (except water) (F, 4); in performing an experiment to show reflection of light (F, O); in performing experiments with the help of magnets (G, O); to determine whether the given thing is a magnet (G, 4); to draw magnetic lines of force (G, 4); in making magnet (G, 3); to determine magnetic field (G, O); to determine directions (N, S, E, W, etc.) (G, O); to determine neutral point (G, 4); in removing dust etc. from the holes in scientific apparatus (H, 3); in taking out the dust etc of a narrow tube (H, 3); in removing a cork from some container in the laboratory (H, 4); in gramophone (I, 4); in fixation of beetles (or other insects) on board (J, 4), in catching fishes (J 4); to lift animal parts (J, 3); to lift microscopic animals (J, 4), surface tension (L, O); deflection (L, 4); conduction (L, 4); refraction (L, 2), reflection (L, 2) expansion of metals on heating (L, 4); reflex action (L, O); preparation of a slide of pollen grains (L, 3), Newton's laws of motion (L, 4); rusting (L, 4); irritability (L, 4); removing air bubbles (L, 4); structure of seed (L, 4); as a good conductor of electricity (M, 4); in conducting heat (M, 4); to pass electricity in something (M, 4); in dissecting frog (N, O);

in operation (N, O) ; in flag labelling (N, O) ; in stitching skin (N, O) ; in dissecting cockroach (N, 4) ; in dissecting earthworm (N, 3) ; in fixing frog's legs (N, O) ; in pinning up the skin (N, O) ; in the dissection of animals (N, O) ; in opening the buccal cavity (N, 4) ; in injecting some medicine (O, O) ; in vaccination (O, 1) ; to insert into the skin of animals (O, 3) ; to take out the blood of animals (O, O) ; to get rid off foreign substances (O, O) ; to insert into the skin of human beings (O, 1) ; in making a hole in boils (O, 3) , in trausfusion of blood (O, O) ; in making a hole in lungs (O, 4) ; in making a hole in some pith (O, 4) ; in taking out medicine from a container (O, O) ; to puncture the diaphragm (O, 4) ; to observe irritability (P, O) ; to observe reflex action (P, O) ; in killing animals (P, 4) ; to determine whether an animal is alive or not (P, 4) ; in making narrow tubular structures clear (Q, 4) , in making various organs of the dissected animals clear (Q, 1) , in dissecting out nerve ring, (or ovary, etc) of earthworm (Q, A) ; to make the nerves clear (Q, 4) ; to rupture the anthers (Q, 2) , to take out the muscles (Q, O) ; to make blood vessels clearly visible (Q, O) in taking out a cell (Q, 4) ; in separating stomata (Q, 4) ; in removing a thin covering (Q, 4) ; in teasing tissues (Q, O) ; in taking out the endosperm of a seed (Q, O) ; in separating various floral parts (Q, 4) , in destroying brain (Q, 4) ; in separating various fibres (Q, 4) ; in separating many filaments of algae (Q, 2) , in making a cavity inside the pith (Q, 4) , in separating the fungal hyphae (Q, 4) ; in making the frog unconscious (R, O) ; to see the effect of injury to cardiac muscles (R, 4) ; in pithing (R, 3) ; in making a needle (S, O) ; in making the needle to be used in galvanometer/stop-watch/ammeter/voltmeter/magnetometer (S, 2) , in making slide (T, O) , in removing air bubbles (T, 3) ; putting cover-slip over the slide (T, O) in putting a small section on a slide (T, 4) , in lifting outer surface of onion scale leaves while making a slide of onion cells (T, 4) ; in making models (U, O) ; to show prickles in a model (U, 4) , to show thorns in a model (U, 4) ; to show pedicel of a flower in a model (U, 4) , to find out relative density (V, 4).

ITEM 10 *Model showing reflex action,*

Categories :

A Material in construction

B. Use of machines

C Use of magnetic devices

D. Use of electrical device

E. Change of colour and form
F. Emphasis on action
G. Multiplication
H Setting in vitro or in vivo
J Anatomical changes
K. Rearrangements
L. Substitution
M. Magnification
N. Addition

Responses :

Glass plate (A, 3) ; wood (A, O) ; gramophone record (A, 4) , plastic (A, O) ; cloth (A, 1) , plaster of paris (A, O) ; tin (A, 3) ; metal (A, 2) ; bamboo (A, 4) , thermocol (A, 3) ; clay (A, 3) ; muscles of magnet (G, O) ; skin of iron (A, O) ; use of machine to show action (B, 4) ; skin of magnet (C, 4) ; use of magnets (C, 3) ; passing electricity through the model (D, O) ; use of an electromagnet (D, 3) ; switch in place of skin (D, 3) ; availability of light (D, 4) , electric motor to show action of muscles (D, 4) , use of generator to pass electricty (D, 4) ; use of bulbs (D, 2) ; nerves of Nichrome wire (D, O) ; use of a battery (D, 4) ; use of a cathode near the skin (D, 4) ; use of electrolytes (D. 4) ; use of good conductors of electricity for muscles (D, 4) , skin of green colour (E, 4) ; changed colour of skin (E, 4) ; skin of pink colour (E, 4), muscles of dark red colour (E, 4) ; coloured body parts (E, 3) ; different colour of skin and muscles (E, O) , spinal cord of red colour (E, 4) ; skin of natural shape (E, 4) ; dynamic model (F, 4) , use of chemicals to show action (F, 4) ; mobile muscles (F, O) ; show the reflex action inside a frog (H, 1) , use of animal in place of card board (H, 3) ; keeping a membrane between white matter and grey matter (J, 4) , use jelly like substances for showing white/grey matter (J, 4) , organs capable of being detached (K, 4) , use of frog's skin for skin (L, 4) ; motor nerves of wire (L, 4) ; sensory nerves of a bunch of wires (L, 4), use of key at the place where pin was to be inserted inside the body (L, 4) ; use of rubber tubes in place of muscles (L, 4) ; use of copper wires in place of muscles (L, 3) ; use of wires in place of muscles (L, 2) ; spherical ring of metal in place of spinal cord (L, 4) ; metal plate in place of skin (L, 4) , spinal cord of goat's urinary bladder (L, 4) ; use of natural muscles (L, 2) , use of real skin (L, 4) ; use of bulb in place of muscle (L, 3) ; muscles replaced by a group of plastic tubes (L, 4) ; nerves of a magnet (L, 4) ; nerves replaced by electric wires (L, 3) ; use of capillary tubes with water and bubbles in place of muscles (L, 4) , skin replaced by a tube (L, 4) , nerves replaced by a wire (L, 1) ; nerves of

capillary tube (L, 1) ; muscle replaced by a soft iron piece (L, O) ; nerves of glass tube (L, 4) ; skin of Alluminium foil (L, 4) , use of leather in place of skin (L, 4) , nerves replaced by silk thread (L, 4) ; larger size of muscles (M, 2) ; thick skin (M, 4) ; enclosing wires representing motor or sensory nerve fibres in a glass tube (N, 4) ; adding a magnet to the muscles (N, 2).

ITEM (11) . *Model of parrot,*

Categories :

A. Material in construction

B. Use of mechanical devices

C. Use of magnet

D. Use of electrical devices

E. Use of optical devices

F. Change of colour and form

G. Emphasis on action

H Multiplication

I. Ecological niche

J. Use of chemicals

K. Morphological changes

L. Anatomical changes

M. Rearrangements

N. Substitution

O. Subtraction

P. Addition

Q. Magnification/shortening

Responses ·

Plastic instead of clay (A, O) , iron in place of clay (A, O) ; glass instead of clay (A 2) ; sponge instead of clay (A, 4) , thermocol instead of clay (A, 4); wood in place of clay (A, 2); brass in place of clay (A, 4); metal in place of clay (A, O), cement in place of clay (A, O) ; steel instead of clay (A, 2), gold instead of clay (A, 4); rubber in place of clay (A, 4); plaster of paris in place of clay (A, 3) ; coloured paper in place of clay (A, 4) ; wax instead of clay (A, 4) , cotton fibres instead of clay (A, 4) , internal organs of metal (A, 4) ; internal organs of magnet (A, 4) ; internal skeleton of plastic (A, 4) , wings of iron (A, 3) wings of tin (A, 3) ; wings of plastic (A, 3) , wings of rubber (A, 4) , beak of plastic (A, 4) ; tail of cotton fibres

(A, 4) ; legs of lac (A, 4) ; wings of a metal plate of less weight (A, 4) ; beak of cloth (A, 4) ; eyes of carbon (A, 4) ; tail of electric wire (A, 4) ; claws of metal (A, 4) ; wings of leaves (A, 4) , bones of wood (A, 4) ; wings of cotton fibres (A, 4) ; beak of glass, (A, 3) ; claws of magnet (A, 4) ; beak of magnet (A, 4) ; legs of iron (A, 4) , skin of green coloured shaneel cloth (A, 4) ; legs of Tungston wires (A, 4) ; legs of metallic wires (A, 4) ; claws of thick wires (A, 4) ; claws of rubber (A, 4) ; legs of wood (A, 4) ; neck of magnet (A, 4) ; attaching wheels to the legs (B, O) , using a machine to make it capable of taking a flight (B, 4) ; using a machine to make it able to walk (B, O) , use a lever system to make its legs movable (B, 4) ; use a machine to enable it to speak (B, 4), use of a magnet (C, O) ; use of electro-magnet (C, 4) ; use of electric bell (D, 2), use of electric cell, (D, O); passing of electricity inside the parrot (D, O) ; making an electric circuit inside the parrot (D, 4) ; use of electric discharge to show eyes, (D, 4) ; eyes of lenses (E, 4) ; use of camera (E, 4) ; eyes of mirror (E, 4) ; stretched wings (F, O) ; beak of red colour (F, 3) , in the situation of eating fruits (F, 3) , in the posture of flying (F, O) ; use of natural colour (F, O) , capable of taking food (G, 4) , mouth capable of opening and closing (G, 4) , movable legs (G, 4) , movable eyes (G, 4) , movable beak (G, O); movable eyes (G, O), tongue capable of being protruded (G, 4), capable to perch at the branch of a tree (G, 2) ; to make it capable of flying (G, O) , to enable it to produce the typical parrot like voice (G, O) , to make it capable of walking (G, O) ; to make it capable of laying eggs (G, 4) ; capable to reproduce (G, 4) ; able to respire (G, 4) , able to jump (G, 4) , many parrots (H, 4) , two parrots (H, 4) , kept inside the cage (S, 4) , sitting at the nest (I, 4) ; sitting at an iron rod (I, 4) ; sitting at a green twig (I, 1) ; straight head (K, 4) keep a fruit in its beak (I, O) , putting arsenic or copper sulphate inside its body (J, 4) ; filling a gas inside it (J, 4) ; using petrol inside the body (J, 4) ; make its legs clear with respect to various structural details (K, 3) , clearly visible retrices (K, 4) ; claws adapted for burrowing (K, 4) , make tongue inside the mouth (K, 4) , make all organs visible (K, 4) straight beak (K, O) , opened beak (K, 3) ; make web in between the claws (K, 3) ; use of bulbs to show various parts of the animal (K, 4), to make internal structures visible from outside (L, O); internal skeleton visible from outside (L, 4) , hollow bones (L, 2) ; visible brain (L, 4) , using tubes, wires and paper to show circulatory system (L, 4) , take out ovary (L, 4) , take out testis (L, 4) ; visible four chambered heart (L, 4) , organs capable of being detached (M, O) ; organs capable of being rearranged (M, O) ; use of living parrot (N, 2) , use of real wings (N, 2) ; use of artificial wings (N, 2) ; using pearl in place of eye (N, O) ; using coloured glass instead of eyes (N, O) , using stuff/cotton or some

chemical substance in place of internal organs (N, 4), using a marble piece in place of head (N, 4), using capillary tubes in place of legs (N, 4) ;substitution of innermost clay within the body by various organs (N, 2) ; using photo electric cell in place of eyes (N, 4), using a lens in place of eyes (N, 4), replacing beak by a piece of carrot (N, 4) ; replacing eyes by bulb/diamond/prism (N, 4) ; using diamonds in place of iris (N, 4), using electric coil in place of heart (N, 4), using wires in place of muscles (N, 4) ; replacing bones by metal tubes (N, 4) ; using wires for nerves (N, 3) ; using red solution in place of blood (N, 4), using thick wire in place of legs (N, 4) ; substituting muscles by spring (N, 4) ; hollow body (O, 2) ; subtraction of beak/legs/eyes (D, 3) ; subtraction of wings (D, O), joining internal organs with tubes made of plastic (P, 3), adding chain to the ventral surface of the body (P, 3) ; using a string to hang it (P, 4), use of parachute (P, 4) ; use of jet (P, 3), use of a transmitter (P, 4), use of engine (P, 3) ; use of a tape recorder (P, 4) ; adding spring to the beak (P, 4) ; use of a wooden stand (P, 4), using spring inside the neck or beak (P, O) ; adding pinna to the body (P, 4) ; using a membrane over its eyes (P, 4), using bones inside the claws (P, 4), use of radium in eyes (P, 4), adding spring to the lower surface of legs (P, O), add forelimbs to the body (P, 4) ; using the skin of a real parrot over the outer surface of the parrot (P, 4), using a propellar (P, 4), use of a speaker inside the mouth (P, 4); putting Zinc oxide over the beak (P, 4) ; putting telescope into the eyes (P, 4) ; increasing its length (Q, O) ; increasing the length of legs (Q, B) ; increasing the tail (Q, 2) ; enlarging the eyes (Q, 2), increasing the size of wings (Q 2) ; lengthening of neck (Q, O) ; increase in its size (Q, O), shortening of beak (Q, 4), shorten the neck (Q, 4) ; shorten the claws (Q, 4), shorten the legs (Q, 3).

ITEM (12, 13 *and* 14)

These items were designed to measure inquisitiveness only and no separate scoring keys have been prepared for them. The total number of relevant, complete, not easily answerable with the help of the given picture, and unambiguous question-responses gives the inquisitiveness score for various test items

ITEM (15) : *Reasons for the external structures as visible in the abnormal man,*

Categories .

A. Nutrition

B Physiological effects

C. Genetics and reproduction
D Habits
E Environment and adaptation
F Growth and development
G. Diseases
H. Transplantation
I. Defective organs
J. Accidents
K. Effect of toxic substances

Responses .

Deficiency of vitamins (A, O), deficiency of nutrients (A, O), deficiency of proteins (A, O), deficiency of Calcium (A, O); Iron deficiency (A, 3); deficiency of carbohydrates (A, O) ; inadequate intake of essential nutrients (A, O) , lack of essential nutrients in mother's diet during pregnancy (A, 4) ; effect of harmones (B, O) ; improper circulation of various organs within the body (B, 4) , more use of brain in many generations (B, 4) defective digestive system (B, 4) , defective circulatory system (B, 4); defective respiratory system (B, 4) , no functioning of various glands (B, 4) ; no occurrence of life activities (B, 3) , deficiency of thyroxine hormone (B, 4) , improper digestion of food (B, 4) , effect of enzymes (B, 4) ; oxygen debt (B, 4) ; improper circulation of growth harmone (B, 4) ; mutation (C, O) ; heredity (C, O) ; acquired characteristics (C, O) ; chromosomal aberration (C, O) , fertilization of gametes from frog's and man's generative cells (C, 3) ; hybridization (C, O) , rapid rate of cell division (C, 4) , origin of new species (C, 4) ; incomplete meiosis (C, 4) ; changed genetic code (C, 4); less use of lower organs (D, O) ;·more use of visual organs (D, O) , ·more use of auditory organs (D,O) , less use of legs in walking (D, O) ; more use of right hand (D, 2) , more use of one ear (D, 4) ; more use of one feet (D, 4) ; no use of left hand for a long time (O, 2) , no use of legs for a long time (O, O) , no use of eye lids (O, 4) , no use of thorax (D, 2) , more use of mouth (D, 3) ; no use of fingers of hind legs for many generations (D, 4) , more use of larger structures (D, O) , no use of hairs (D, 4) ; use of shoes (D, 4) ; less use of hands (D, O) ; aquatic habitat (E, 4) , effect of environment (E, O) ; adaptation to the environment (E, O) ; effect of cosmic rays (E, 4) ; effects of electro-magnetic radiations (E, 4) ; reduced alimentary canal (F, 4) , no opportunity for development, (F, O) ; more development of brain (F, 1) ; less development of legs (F, O) ; less development of hands (F, O) ; abnormal development of bones (F, 4) ; more developed facial structures (F, 4) ; more development of active organs (F, 4) , less development of inactive organs (F, 4); more developed eyes (F, O), more developed

nose/ear (F, 4) , absence of bones in legs (F, 4) ; less development of muscles (F, 2) ; improper development of thorax (F, O) ; a disease (G, O) ; paralysis of lower body (G, O) ; paralysed legs (G, O) ; hands affected by polio (G, O) ; suffering from ricketts (G, O) ; swollen face (G, 2) , Anemia (G, 4) ; after effects of bacterial infection (G, 4) ; elephant's ears (H, O) ; thorax of a baby (H, 4) ; hands of a rat (H, 4) , fingers of frog (H, 4) ; thorax of frog (H, 4) ; thorax of animal (H, 4) ; defective liver (I, 4) ; abnormal functioning of some glands (I, O) , abnormal functioning of the pituitary (I, 2) ; inactivated thyroid gland (I, 4) ; more accidents in childhood (J, O) ; burning of eye brows, (J, 4) ; head haemorrhage (J, 4) ; after-effects of some accident (J, 4) ; disappearance of fingers in some accident (J, 4) , after-affects of some accident during pregnancy (J, 4) , medicines used by mother: during pregnancy (K, 2), effects of some poisonous substance (K,O) , stinging by honey bee (K, O) , use of injurious medicine (K, 4).

ITEM (16) . *Causes for the survival of the abnormal man after inhaling a capsule containing mixture of poisonous substances like Copper sulphate, acid, and Arsenic etc*

Categories ·

A Physiology

B. Chemical reactions

C. Material used in the construction of the capsule

D. Immunity

E Presence of antidotes

F. Anatomical factors

G Impurity of poisonous substances

H Quantity of poisons

Responses

Different process of digestion (A, 3) ; lack of enzymes (A, 4) , no dis solving of capsule (A, O) ; improper digestion (A, O); no assimilation of digested food (A 4), no digestion (A, O) , no physiological activities (A, 2) ; less power of absorption through intestine (A, 3) , acid contained in the capsule may be hydrochloric acid which has been used in digestion (A, 4) ; no action of digestive juices on the capsule (A, O) ; no reaching of poisonous substance in blood circulation (A, 2); no circulation of blood in the digestive system (A, 4) ; no effect on brain till now (A, 4) ; failure of poisonous substances to produce their effects till now (A, O); capacity of the man to digest the poisonous substances (A, O) , vomiting (A, O) ; no reaching of poisonous

substances to the alimentary canal (A, O) ; absence of blood (A, 4) ; inhibition of growth (A, 4) ; occurrence of some morphological changes (A, 4) ; disposal of the capsule from the body (A, O) ; keeping the capsule to be inhaled in a thing which cannot be digested (A,4) ; neutralization of poisonous substances (B, O); formation of harmless products through physiological reactions (B, 3) , formation of harmless substances as a result of reactions among the poisonous substances (B, O) , capsule made of rubber (C, 4) ; capsule of a hard metal (C, 4) ; capsule of cuticle (C, 4): capsule of a substance that cannot be dissolved (C, O); capsule of some metal (C, 4); capsule of iron (C, 4) ; capacity of the man to take poisonous substances (D, O) ; ability of man to protect himself from poison (D, O) ; has tissues which are resistant to high acidity (D, 4) ; not sensitive alimentary canal (D, 4) ; inability of the poisonous substance to affect man (D, O) , presence of antidotes in the body (E, O) ; use of anti-poison drugs before (or after) the intake of the capsule (E, O) ; presence of anti-poison substances inside the capsule (E, 4) , presence of special enzymes to make the poisonous substance ineffective (E, 4); undeveloped internal organs (F,3), absence of all internal organs in the body (F, 2) , absence of heart (F, 4) ; absence of intestine (F, 3) , absence of blood vessels (F, 4) , absence of digestive system (F, 4) ; less developed digestive system (F, O) ; presence of a special gland to secrete antidotes for the poisons (F, 4) ; changes in the digestive system (F, 4) ; short alimentary canal (F, 2) ; different type of protoplasm (F, 4) , impurity of poisonous substances (G, O) ; change of capsule (G, 4) ; less quantity of poisons (H, O); very dilute acid (H, 4).

ITEM (17) · *Difference in presence of granular structures in pictures meant for items* 12 *and* 13,

Responses to this item have not been classified and originality weightage to various responses have not been determined.

ITEM (18) : *Causes for the death of larva present on a leaf,*

Categories ·

A. Absence of water in the test tube

B. No absorption of test tube contents

C Physiological malfunctioning of plant

D Physiology of the larva

E. Ecological effects

F. Relationship with other organisms
G. Nutrition in larva
H. Presence of harmful liquid in the test tube
I Environment in the laboratory
J. Death of the plant
K. Falling of some poisonous substance
L Accident
M. Morphology of plant
N. Chemical effect

Responses :

Absence of water in the test tube (A, 3), consumption of water which was in the test tube (A, 4); presence of such a fluid in the test tube as cannot be absorbed by the plant (B, 4), dry leaf (C, 3), drying of leaves (C, O); nonavailability of adequate oxygen to the larva for use in respiration (C, O), deficiency of water (C, 2), drying of plant (C, O); release of carbon-di-oxide from the leaf (C, 4); no photosynthesis (C, 2); inhibition of the process of chlorophyll production (C, 4), yellowing of leaves (C, 4); feeding on poisonous leaf (D, 4), intake of more carbon-di-oxide by the larva (D, 3); adverse conditions of the ecological niche (E, 4), grazing of the plant by the goat (E, 4); absorption of all oxygen by the animals (F, 4); throwing of waste products by goat over the larva (F, 4); throwing of waste matter by bird on the larva (F, 4), attack of bacteria (F, 4); eating of plant base by the goat (F, 4), larva attacked by the bird (F, 2), sucking of poisonous plant sap (F, 2), killed by the bird (F, 2), killed by the goat (F, 4), injured by the beak of the bird (F, 4); removal of leaves from the plant by animals (F, 4), eating of plant leaves by the goat (F, O), scarcity of the food (G, O); availability of less food for the larva (F, 4); nonavailability of mineral elements for the larva (G, 4), presence of poisonous liquid in the test tube (H, O); presence of harmful fluid in the test tube (H, 3), polluted environment (I, 3); uncongenial conditions for the life of the larva (I, 3); presence of a harmful gas (I, 3); keeping the apparatus in dark (I, 3); absence of oxygen (I, 2), excess of carbon-di-oxide (I, 3), nonavailability of light to the plant (I, 1); no sun-light for the plant (I, 1), death of the leaf (J, 1); death of the plant (J, 4); falling of some poisonous substance on the plant (K, 4); attachment of some poisonous substance to the leaf surface (K, 4); falling down of larva on the ground (L, 3); absence of green leaves (M, 4); presence of such substances in the environment as are capable of absorbing atmospheric oxygen (N, 4).

ITEM (19) : *Block designs,*

Categories :

A. Cell and cell organelles

B Tissues

C. Organs

D. Plant structures

E. Instruments for dissection

F. Animals

G. Plants

H. Bacteria

I. Measuring instruments

J. Virus

K. General biological equipments

L. Pointers

M. Tubes

N. Chemical symbols

O. Optical instruments

P. Electricity based instruments

Q. Chemical formulae

R. Physical appartus

S. Nuclear Physics

T. Equipments used in Chemistry

Responses :

Ribosome (A, 4) , blood cells (A, 4) ; eggs of animals (A, 4) ; mitochondria (A, 4) , plant cell (A, 4) ; nucleus (A,4) ; chromosome (A, 4) ; vacuole (A, 4); cell (A, O) ; cell membrane (A, O); lid cells (A, 4) ; cell wall (A, 4) ; DNA (A, 4) , RNA (A, 4) , muscles (B, 4) ; epidermis (B, 4) ; nervous tissue (B, 4) ; contractile vacuole (C, 4) ; food vacuole (C, 4) ; zygote (C, 4) ; stomach (C, 4) ; electric organ (C, 4) ; eye (C, 4) ; tympanum (C, 4) , spleen (C, 4) , gall bladder (C, 4) ; bones (C, 4) ; heart (C, 4); intestine (C, 4) ; beak (C, 4) ; blastula (C, 4) ; insect wing (C, 4) ; testis (C, 4) ; pinna (C, 4) ; ovary (C, 4) ; mouth parts of an insect (C, 4) ; tail (C, 4), liver (C, 4), scales (C, 4); antennae (C, 4), ribs (C, 4), morula (C, 4); leg (C, 4) ; kidney (C, 4) , eardrum (C, 4) ; blood vessel (C, 4) ; iris (C, 4) ; pollination tube (D, 4) ; stomata (D, 4) ; spores (D, 4) ; cortex (D, 4), petiole (D, 4) ; bud (D, 4) , androecium (D, 4) ; root of *Brassica* (D, 4) ; compound leaf (D, 4) ; fruit (D, 4) , ovary of a flower (D, 4) ; xylem (D, 4) , phloem (D, 4) ; gynoecium (D, 4) , flower disc (D, 4) ; cambium

(D, 4) ; leaf of moss (D, 4), cone (D, 4) ; leaf let (D, 4), sepals (D, 3) ; petals of a flower (D, 3) ; florets of a flower of compositae family (D, 3), typical root(D, 3) ; sunflower (D, O) ; a typical flower (D, O), stem (D, O) ; moss capsule (D, 4) ; forcep (E, 4), razor (E, 4), scissors (E, 4) ; pin (E, 4) ; needle (E, 4) ; petridisc (E, 4) ; *Ascaris* (F, 4) ; *Amoeba* (F, 4) ; starfish (F, 4) ; fly (F, 2) ; fish (F, 4) ; earthworm (F, O) ; snake (F, 4) ; round worm (F, 4), tree (G, 2), *Opuntia* (G, 2) ; fungus (G, 4) ; *Cuscuta* (G, 4), algae (G, 4) ; a plant (G, O) ; sugarcane (G, 4) ; *Ulothrix* (G, 4) ; cactus (G, 4) ; spirogyra (G, 4) ; bacteria (H, O) ; vernier (I, 4), screw guage (I, 4), thermometer (I, 4) ; burette (I, 4) ; measuring cylinder (I, 4), pipette (I, 4) ; scale (I, 4) ; virus (J, 4) ; knife (K, 4), slide (K, 4) ; collection tube (K, 4) ; aquarium (K, 4) ; dissection tray (K, 4) ; specimen jar (K, 4) ; cover slip (K, 4) ; wash bottle (K, 4) ; pointer (L, 4), tubes (M, 3), H (N, 2), O (N, 4), prism (O, O) ; glass plate (O, 2), telescope (O, 4) ; eye piece of microscope (O, 4), periscope (O, 4), mirror (O, 4), lens (O, 4), plane mirror (O, 4); optical bench (O, 4) ; concave lens (O, 4), cell (P, 4), fuse (O, 4), switch (P, 4), lamp (P, 4) ; key (P, 4), fan (P, 4) ; tube light (P, 4) ; voltmeter (P, 4), Benzene ring (B, 4); Napthalene (Q, 4), O_2 (Q, 4), SO_2; (Q, 4); CO_2 (Q,4); NH_4 (Q, 3); H_2O (Q, 3); HNO_3 (Q, 3), $AgNO_3$ (Q_3,), I_2 (Q, 2); H_2 (Q, 2) H_2SO_4 (Q, O); a piece of glass (R,O), sprit level (R,4), table of science room (R, 4); simple pendulum (R, 1); wooden block (R, 2); a lever (R, 4); magnet (R, 4); resonance tube (R, 4); filter pump (R,4); calorimeter (R,4), siphon (R, 4), pulleys (R, 4) ; cylinder (R, 4) ; drawing board (R, 4) ; cycle pump (R, 4) ; nucleus (S, 4) ; electrons (S, 4); structure of an atom (S, 4), proton (S, 4), spectrum (S, 3) ; rocket (S, 4), molecule (S, 4) ; jet (S, 4), passing tube (T, 4) ; conical flask (T, O) ; flask (T, 4); beaker (T, O) ; burner (T, O) ; sprit lamp (T, 4) ; filter paper (T, 4) ; gas jar (T, 4) ; weight box (T, O) ; woulf bottle (T, O), funnel (T, O), wire gauze (T, O) ; ignition tube (T, 4), test tube stand (T, 2), weight (T, O), burette stand (T,4); test tube (T,O), sink (T, 4); tripod stand (T, 4).

4.4.2. *Scoring*

First of all students' responses were checked to ensure that no response has been rewritten. At the same time all of the irrelevant, ridiculous, incomplete and ambiguous responses were searched for and marked with coloured/ink pencil. They were ignored while scoring. Responses of all tests except the 'Inquisitiveness Test' were scored for fluency, flexibility and originality with the help of above mentioned keys The total number of responses given by a student for a particular item indicates his or her fluency score. The number of categories to which responses to an item

belong gives flexibility score Scores obtained by an individual on various items were added together to get a composite score on scientific creativity

4. 4. 3 *Peparation of Final Form of TSC*

After being scored, the answersheets were arranged in an ascending order of scientific creativity scores and twenty answer sheets were selected from either ends in order to be able to compute t- ratios.t-ratios were not calculated for item no 4, 13, and 17 because the number and variability of responses for these test items was less than 40. All other items succeeded in elicting 46-124 responses. The t-values are shown below :

Table 4.2 *t-values for various items of the preliminary form of tests of scientific creativity*

S N of Item	Mean scientific scorescreativity		Standard Deviations		t ratio	Level of sig.
	Upper Group	Lower Group	Upper Group	Lower Group		
1.	13 1	13 0	5.1078	5.0794	0 0621	NS
2	18 3	13.4	6.3277	7.8000	2.1818	.05
3	16 3	16.5	6.6491	7.5928	0.8862	NS
5	16 4	8.7	6.9599	3.5930	4.3965	01
6	21.7	9.1	10 8816	3.5623	4.9213	01
7·	10 7	7 4	3.7961	3.7202	2.7766	.01
8.	18.1	9 3	8.2879	5.2924	4 0020	.01
9.	15.5	4 8	6.2968	4.3772	6.2398	.01
10.	16 4	4.9	6.9742	3 9862	6 9646	.01
11.	17.9	6.8	1.4697	5.4185	8.7415	.01
12.	5 2	4 0	1 4597	1 7321	2 3627	.05
14.	6 7	5.3	2.3259	1.7349	2 1578	.05
15	18 0	6 8	6 7082	4.8125	6.0668	.01
16.	10 9	4.9	3.4771	2.7000	6.0951	.01
18.	12 6	10.9	6.3119	4 0608	1.0130	NS
19.	23.5	8.8	10.1316	6.4777	5.4859	.01

Observation of table 4.2 shows that thirteen items, 2, 5, 6, 7, 8, 9, 10, 11, 12, 14, 15, 16 and 19 are worth retaining However, items 2 and 5 were selected for inclusion under 'Consequences Test' ; 6 and 9 for 'Unusual Uses Test', 11 for 'Product Improvement Test'; 12 for 'Inquisitiveness Test , 15 and 16 for 'Guess Causes Test' and 19 for 'Block Design Test'. All of these were comparatively more successful than the remaining counterparts in discriminating highly creative science students from those with low scientific creativity. At the same time, items 7 and 8 were included in 'Unusual Uses Test' , 10 for 'Product Improvement Test' , and 14 for 'Inquisitivenes Test' These three tests constituted parallel forms for the respective subtests included in the battery to be used for the present research.

4 5. The Battery of Tests to Measure Scientific Creativity

Thus, the final form of the battery of tests to measure scientific creativity consists of six tests, *viz.* (1) consequences test, (2) unusual uses test, (3) product improvement test, (4) inquisitiveness test, (5) guess causes test, and (6) block design test Out of these six tests first, second and fifth tests have two items each and the maximum time limit for all except the block design test is six minutes. The time limit for responding to block design test is ten minutes On the whole one student takes about 53-60 minutes to complete the test

4.6 Reliability of the tests

Reliability of a measure is an important concern of every test maker Ascertaining reliability requires a scrutiny of the calibration of the instrument or its internal consistency, as well as its stability as it is used again and again. Khatena (1973) has pointed outthat test-retest reliability of a creative measure presents several problems The multidimensional nature of the construct of 'Scientific Creativity' and unrepresentative sampling of stimuli from an inadequately known universe of stimuli , the unpredictable imaginative-motivational forces that operate, time interval variable, the reactive effects of retesting with the same form of tests to measure scientific creativity and the uncertain equivalence of alternative forms of the measure are extraneous elements that presented problems to us in determining the reliability of our tests of scientific creativity. As a result of these problems it was thought that computation of test-retest reliability will not be of much use. However, attempts were made to find out split half reliability and parallel form reliability.

In order to find out parallel form reliabilities, three parallel forms of three tests, *viz.* unusual uses test, product improvement test and inquisitiveness test were administered to thirty one students (including fifteen girls) studying in two average schools *viz.* Government Inter College, Mainpuri and Government Girls Inter College, Mainpuri. All of them were studying Physics, Chemistry and Biology in the intermediate classes Product moment coefficients of correlation were calculated between scores obtained by individuals on the actual tests (included in the battery) and the comparable parallel forms. This was done separately in case of the three tests and the resulting parrallel form reliabilities were .53007 for the 'unusual uses test', .78889 for the 'product improvement test', and .54169 for the 'inquisitiveness test'. All of them were significant at .01 level.

'Split-half reliabilities' were computed for three tests, *viz.* .'consequences test', 'unusual uses test' and 'guess causes test'. These three tests consisted of two items each Each one of them was scored for fluency, flexibility and originality as suggested earlier and with the help of scoring keys. These tests were administered to 120 students. Correlations between individuals' scores on both items of the same test were calculated in case of the three types of tests All correlations were corrected for length and the resulting coefficients are .57331 for 'consequences test', .63180 for 'unusual uses test' and .50181 for 'guess causes test'

4 4 Validity of tests

Of all the problems relative to the measurement of creative abilities, validity has called for the most urgent concerns Khatena (1973) reports "Measures of creativity originating from constructs whose complexities are better recognized than understood have built in validation problems which the combined efforts of three University of Utah conferences (Taylor, 1956, 1958, 1959) and the critical and constructive evaluation directions by prominent men in the field (e g Mackler & Shontz, 1965 ; Mc Nemar, 1964, Taylor, 1965 , Wallach & Wing, 1963 , Wallach & Kogan, 1965 , Yamamoto, 1965) have to date been unresolved" This observation appears to be valid in case of scientific creativity also Treffinger et al (1971) make clear that each instrument mirrors the particular set of beliefs and preconceptions of its developer concerning the nature of creativity. Criterion problem represents the most challenging aspect of all researches into creativity (Shapiro, 1972).

To begin with, the investigator looked into the criteria of creativity which had been used by researchers to measure scientific creativity Significant among them were judgements of supervisiors or professionally qualified people, number of products defined as creative pursuits of activities in the field of scientific research, number of publications, promotion rate, number of patents, etc It is difficult to determine the relative importance or appropriateness of these and other criteria such as creative personality, creative motivation, or biographical inventories Their suitability for identifying creative scientific talent among students has not been a well-established fact Since creative scientific talent, from the standpoint of aptitude, is composed of numerous special abilities, and since criteria of creative performance in the field of science are also complex, we cannot hope that one test of creative scientific performance will correlate highly with those criteria.

The above discussion indicates problems related to criterion validity However, we can say that the present tests of scientific creativity measure scientific creativity on the basis of (1) the way the tests have been developed; and (2) the opinions expressed by nine experts Further, the author tried to validate his test against teacher's ratings and peer nominations.

Two teachers of a boys' school and two teachers of a girls' school showed willingness to rate their students with reference to fluency, flexibility, originality and inquisitiveness. These concepts were explained to them with special reference to scientific creativity and they were requested to rate the given students (i.e. to whom tests of scientific creativity had been administered) on a five point scale It was hoped and expressed to them that they were the best judges of the scientific creativity of their students and the present researcher was interested in their unbiassed and cautious ratings The categories in the scale were 'least', 'less', 'normal', 'much', and 'very much' These ratings were quantified using 1, 2, 3, 4, and 5 scores for the five categories respectively. Scores for every student with respect to four attributes were added together. The same procedure was adopted for quantification of ratings given by the other teacher. Scores derived from ratings by two teachers were added together and divided by two so as to get an average score (teacher's rating) for every student of a class. Later, these students were rank-ordered on the basis of these scores. They were again ranked on the basis of scores on tests of scientific creativity Then, Kendall rank coefficient of correlation (Tau) was worked out using student's ranks on both variables Significance of 'Tau' was tested with the help of 'Z' values (Table 4.3). This process was repeated for students of the other school also.

Table 4 3 *Kendall rank coefficient of correlation between ranks on teachers' ratings and tests of scientific creativity*

S N	School	No of subjects	Tau	Z	Level of Significance
1.	Govt Inter College, Mainpuri	23	.3503	2·34	·0096
2	Murari Lal Khatri Girls Inter College, Agra	30	.4427	3·44	.0003

Observation of the above table reveals that teachers' ratings and scores on tests of scientific creativity are associated in the population from which the samples were drawn.

Peers' nominations were used for computing contingency coefficients. Instructions given to students are .

"Please write down the names of students (one fifth of the total number in the class) of your class that you think have the best imagination and think of the most clever and new ideas for making various scientific models or doing scientific activities. Imagine that your class has to produce some scientific thing *e. g* project, science magazine, model etc. by itself Who are the children who would contribute the most towards this work ? Do not just write down the cleverest children, the ones who get the best marks, or the ones you like best, or the first ones you think of Try to think about all the students of your class (as listed on the next page) before you make up your mind. Please do write the names of .. . students who are poor in these abilities."

This technique has been used by Katheleen Dewing (1970) Contingency coefficients (given in table 4·4) were found out between peer nominations (ratings) and scores on tests of scientific creativity It was significant at 01 level

Table 4 4 *Relationships expressed by contingency coefficients between peer ratings and scores on tests of scientific creativity*

S. N.	School	Sample size	C	Chi-square
1	Murari Lal Girl's Inter College, Agra	30	·5599	13 70*

*Significant at. 01 level

As tests of the present battery were designed to measure scientific creativity, the author wanted to know whether all the tests included in the battery are successful in measuring scientific creativity or not. This type of intrinsic validity was found out by correlating students' scores on various tests with the total scientific creativity scores obtained by students on the battery. The resulting product moment coefficients of correlation are as follows:

Table 4 5 *Validity coefficients for TSC*

S. N.	Name of Test	Validity coefficient
1.	Consequences Test	69439*
2.	Unusual Uses Test	. 82054*
3	Product Improvement Test	80362*
4.	Inquisitiveness Test	. 60316*
5.	Guess Causes Test	. 71074*
6.	Block Design Test	. 63761*

*Significant at .01 level

Observation of the table 4 5 shows that all the intrinsic validity coefficients for various tests of the battery are signicant at 01 level. Thus tests of scientific creativity are valid.

Construction and Standardization of School Environment Inventory

Measurement of school environment is vital. At the present time there are two main approaches to the assessment of school environment One approach that has been used in many studies, is based upon students' observations (Amidon & Flanders, 1961 ; Cogan, 1954 , Flanders, 1951 ; Steele, House & Kerins, 1971). Ehman (1970) and Remmers (1963) indicated that students' observation approach provides an accurate picture of classroom environment. Similarly Goldberg (1968) pointed out that the validity of using students' observation as an approach for determining differential student reaction to teacher and classroom activities stems from the fact that students observe more of the teacher's typical behaviour than is usually available to the outside observer. In addition, students are directly involved in the classroom activities. However, there are two major shortcomings in most observational studies. One is the pooling of all pupils' ratings, without consideration of individual differences in pupils' perceptions, despite the fact that extensive research has shown that individual personality factors influence perception (Bruner, 1958). The other is the use of broad variables which do little to clarify the complexit of the classroom learning environment (Goldberg, 1968)

The other promising approach is measurement of the perceived sycho-social environment (Randhawa and Fu, 1973) Silbergeld, et al (1975) have pointed to differences in actual and perceived School environment In fact a teacher may be quite strict but students perceive him as permissive. Moos (1974) thinks that perception is the primary determinant of manifest classroom behaviour. It is this perception of school environment by children that may help or hinder the realization of goals for children in general and the development of scientific creativity in particular.

Several instruments have been developed to measure perception of school environment Some of the notable instruments are as follows

5.1. Review of Tools

Rabinowitz and Rosenbaum (1958) developed a 'Teacher-Pupil Rapport Scale' to measure students' perception of the classroom climate in each of their major academic subjects namely English, Mathematics and Science.

Stern and Pace (1960-70) constructed a test called 'High School Characteristics Index' for students of 9-13 grades. This test provides 40 scores-30 press scores(abasement assurance, achievement, adaptability-defensiveness, affiliation, aggression—blame avoidance, change-sameness, conjunctivity—disjunctivity, counteraction, deference-restiveness, dominance-tolerance, ego-achievement, emotionality-placidity, energy-passivity, exhibitionism-inferiority avoidance, fantasied achievement, harm avoidance-risk taking, humanities and social science, impulsiveness-deliberation, narcissism, nurturance, objectivity-projectivity, order-disorder, play-work, practicalness-impracticalness, reflectiveness, science, sensuality-puritanism, sexuality-prudishness, supplication-autonomy, understanding), seven factor scores, *viz* intellectual climate, expressiveness, group life, personal dignity, achievement standards, orderliness, and practicalness based on combinations of press scores and three second order factor scores, *viz* developmental press, orderliness, and practicalness.

Walberg (1969) constructed a 'Learning Environment Inventory' He used Getzels-Thelen theory of the class as a social system The LEI consists of fourteen scales, each with seven items describing characteristics of classes The 14 scales have been labelled as intimacy, friction, cliqueness, satisfaction, speed, difficulty, apathy, favouritism, formality, direction democratic, disorganization, diversity and environment. The range of test-retest reliabilities is ·43 to 82 and each scale among 14 scales is relatively independent Later six of the original items in the 14 scales of the LEI were modified and a 'Competitiveness' scale was added (Anderson, Walberg and Welch, 1969 , Anderson, 1971) The total number of scales is fifteen and each scale still contains seven items A total of 105 items comprises the LEI in its most recent form. The respondent expresses the extent of his agreement or disagreement with each statement. Though the tool seems to be a good one, still it has two serious flaws in it— (1) it aims at providing the estimate of the collective student perception of classroom climate, and (2) there exists considerable overlapping among

various scales, *e. g* favourtitism, friction, and intimacy ; difficulty, speed, formality, apathy, democratic, disorganization and cliqueness Walberg and Anderson (1972) provided the most recent validity data across eight subject areas and across classes of different mean IQ levels. However, the restrictiveness and nonrepresentativeness of the sample used in their study warrants further investigation of the validity of this instrument.

Based on Murray's concept of environmental press, Steele, House and Kerins (1971) developed a 'Class Activities Questionnaire' for assessing both cognitive and affective dimensions of instructional climate The CAQ activities imply either levels of thinking or affective classroom conditions. It assesses four major dimensions of instructional climate each of which is composed of a number of factors In all 25 items in the questionnaire represent sixteen factors, *viz.* memory, translation, interpretation, application, analysis, synthesis, evaluation, discussion, test-grade stress, lecture, enthusiasm, independence, divergence, humour, teacher talk and home work The four dimensions are lower thought processes, higher thought processes, classroom focus and classroom climate This instrument asks students' agreement or disagreement on a four point scale describing general kinds of activities which characterize their class. It can be administered to students of grade six and above. It is worth-noting that the sample of items (=25) used to measure 16 characteristics of school environment is inadequate and sufficient evidence about the reliability and validity of this tool is lacking.

Sadker (1973) constructed an instrument called 'Elementary School Environment Survey' for students of fifth and sixth grade. Students respond to each of the 80 statements included in the test by reporting whether the given statement is a true or a false description of their elementary school. The revised version of the tool reflects six environmental dimensions, *viz.* alienation, humanism, autonomy, morale, opportunism and resources.

Tricket and Moos (1974) developed 'Classroom Environment Scale' which measures nine dimensions of the classroom environment grouped into three conceptual categories . interpersonal relationship dimensions including student—teacher and student-student relationships; personal growth dimensions, such as academic competition among students and system maintenance and change dimensions, such as teacher control or innovation. Test-retest reliability coefficients ranged from 72 to ·90 It discriminates between the classrooms of different subjects.

Silbergeld et al. (1975) constructed a 'Classroom Atmosphere Scale'. It consists of twelve subscales or dimensions, *viz* aggression, submission,

autonomy, order, affiliation, involvement, insight, practicality, support, spontaneity, variety and clarity Each subscale contains 10 true-false items concerning specific behaviours in the classroom

Bhatnagar (1977) constructed a 'Treatment Environment Inventory' on the lines of Moos's (1974) 'Ward Atmosphere Scale'. This inventory yields scores on ten dimensions of the environment, *viz.* support, practical orientation, involvement, autonomy, order and organization, programme clarity, staff control, personal problem orientation, anger and aggressions, and spontaneity. It was meant for students of ninth class.

The Pennsylvania State University 'Social Emotional Climate Index' measures seven dimensions, *viz.* learner supportive, problem structuring, neutral, directive, acceptance or clarifying, reproving, disapproving or disparaging, and teacher supportive (Withall, 1979)

Perusal of the above review reveals that there exists a dearth of highly reliable and valid tools that measure children's perceptions of their school environment in terms of teacher—pupil interactions in the Indian context and therefore the need to construct such a tool is the burning need of the time

5. 2 Construction and Standardization of School Environment Inventory

5 2 1. *Construction of Items*

Having decided the dimensions of the school environment to be measured, the selected dimensions were defined in operational terms Then twenty to twenty five items were written initially to measure children's perceptions of their school environment with respect to various dimensions. Each of these items was read and evaluated six times on different occasions by the author As a result of these efforts several items were reworded each time, some were deleted and the resulting pool of items consisted of about sixteen to twenty items for each dimension except that for creative stimulation, which included twenty two items These items were typed and were subjected to expert scrutiny The typed inventory was discussed with seven experts and four school teachers teaching intermediate classes in Mainpuri city The operational definitions of various environmental dimensions were also presented to them and they were requested to judge whether each item designed to measure a particular dimension measures it. Their opinions were noted by the researcher in the form of 'Yes', 'No', or 'Doubtful' Items which were labelled as 'No' or 'Doubtful' were changed in consultation with them. Thus some items

which were labelled as doubtful by one of the judges were modified. Irrelevant items were dropped in a bid to improve the content validity of the inventory. This preliminary form was rewritten with the help of carbon paper and the inventory was administered to 40 students of XI class of Christian Inter College, Farrukhabad The responses were analysed to explore their applicability. The situations in which students responded to various items, were carefully observed to locate vague items or items whose language was too difficult to understand Some students expressed difficulty in understanding some words and these words were explained to them. Later two items containing such words were modified. This inventory was got printed along with the necessary instructions for students.

5.2.2 *Item Analysis*

The preliminary form of the inventory was administered to 127 students studying in XI and XII classes of five schools of Mainpuri, Farrukhabad and Kanpur cities. In view of the instruction which allowed them not to respond to any item which is not considered to be worth-answering by them, some students omitted many items. Sheets of subjects who did not respond to some or many of the items were separated and the remaining 93 sheets were used for item analysis.

These sheets were scored using O-4 marks. A response in 'Never' category in case of four dimensions of the inventory, *viz.* 'Creative Stimulation', 'Permissiveness', 'Cognitive Encouragement' and 'Acceptance' was assigned a score of zero. 1, 2, 3 and 4 scores were assigned to responses in 'least', 'sometimes', 'often' and 'mostly' categories respectively. This scoring pattern was reversed in case of responses belonging to two dimensions of the inventory, *viz* 'Control' and 'Rejection'

After having scored various items of the 93 test papers, scores on various items belonging to specific dimensions were added together to yield six composite scores on six dimensions of the 'School Environment Inventory' for each individual. Now these sheets were arranged in an ascending order of scores with the lowest composite score on a dimension at the bottom and the highest score at the top This process was repeated six times for six dimensions respectively and each time twenty five sheets were selected from either ends of the ordered sheets (27 per cent of 93). These sheets represented the individuals in upper (UCG) and lower (LCG) criterion groups. Cut-off score points for the two groups have been given in table 5.1.

Table 5 1 *Cut-off points for upper and lower criterion groups for various dimensions*

S. N.	Dimensions	Cut-off score points for	
		HCG	LCG
1.	Creative Stimulation	64	49
2.	Cognitive Encouragement	34	27
3	Permissiveness	34	25
4	Acceptance	28	18
5	Control	21	30
6.	Rejection	33	43

The t-values were calculated to find out discrimination value for each item of every dimension of the school environment. Twenty items with highest t- values, significant at 01 level, were selected for inclusion under the dimension of creative stimulation Ten items with highest t-values were retained for the final form for inclusion under each of the remaining dimensions of school environment as perceived by children All these t-values are given in table 5 2 Except one all were significant at 01 level. Thus, seventy items could be selected for six dimensions. The sequence of dimensions as well as the order in which various items were to appear in the final form was determined through random selection.

Table 5 2 *Mean scores, standard deviations and t-values for items selected in the final form of school environment inventory*

I. N_1.	Dimension$_2$	Mean scores		Standard Deviation		t-ratio
		UCG$_3$	LCG$_4$	UCG	LCG	
1	2	3	4	5	6	7
1	CRS	3 36	2.56	0.9330	1 2986	4.82
2.	COE	3.52	1 52	0 5741	1.4730	6.33
3	ACC	2 96	1.84	1 2484	1.3764	3 01
4.	CRS	3.56	2.12	0.6974	1.2432	5 05
5.	PER	3.32	2.28	0.7332	1.4288	3.24

1	2	3	4	5	6	7
6	REJ	1.48	3.16	1.1703	1.0461	5.35
7	CON	1 28	3.04	0.4490	1 3705	6.10
8.	CRS	3.36	2 12	0 6248	1.1771	4.37
9.	COE	3.20	1.52	0 6325	1 2687	5.93
10.	ACC	3 04	0 80	0 6621	1.7088	6 11
11	CRS	3 52	2.60	0 8060	1.0198	3.54
12	PER	2 04	0 60	1 5869	0.7483	4.10
13	REJ	1.60	3 08	1 2000	1.1285	4.71
14	CON	2 96	3 84	1 4277	1.1552	2 40
15.	CRS	3.20	1.56	0 5657	1 2674	5 91
16.	COE	2.28	0 92	1 3717	0 9347	4.10
17.	ACC	3.56	1.92	0 6375	1.2303	5.92
18.	CRS	3.60	2 12	0 6928	1 3948	4.75
19	PER	2.12	0 36	1 5052	0.6248	5 40
20	REJ	1 24	2 68	1.2093	1 1565	4.30
21.	CON	1.92	3.72	0 8908	1.1143	6.31
22.	CRS	3.12	1.60	1 0323	1.0954	5.05
23.	COE	3.40	2.28	0 8485	1.4838	3 28
24.	ACC	3.12	1.44	0 9516	1.1342	5.67
25.	CRS	3 16	2.24	0.9666	1.3048	2.83
26	PER	3 20	1.84	0.8944	1.3172	4 27
27.	REJ	1.28	3 24	1.1143	0 9499	6.69
28.	CON	2.08	3 64	1 2937	1.2290	4.37
29.	CRS	2.56	1 16	1.3291	0.9243	4.32
30.	COE	3.72	2 36	0 5307	1.2290	5.08
31.	ACC	2.72	0.96	1.0008	0.8237	6.79

1	2	3	4	5	6	7
32.	CRS	2.60	1 36	1.2961	1.2611	3.43
33.	PER	3.24	2.00	0.7088	1.2649	4.28
34.	REJ	1.44	2 84	1.1689	1.0072	4.54
35.	CON	1.36	2.88	0 6248	1 2432	5.53
36.	CRS	2.72	1.12	1.1143	0.9516	5 46
37.	COE	3.52	1 48	0 7547	1.2687	6.91
38.	ACC	3.12	0 96	0.9516	1.1128	7.52
39.	CRS	3.20	1.16	1.0198	0.7838	7 93
40.	PER	1.80	0.36	0.8000	0 6248	7.09
41	REJ	1 08	3 36	1 1973	0 9749	4 15
42.	CON	3.44	4.36	1 2027	0 9330	3.02
43.	CRS	2 96	1.28	0 9992	1.3714	4.95
44.	COE	3.76	3.16	0.4271	1.0072	2.74
45.	ACC	3 60	1.68	0 4899	1 2238	7.28
46.	CRS	2.96	0.84	0 9583	0 8333	8 35
47.	PER	2 08	0.48	1 2937	0 5741	5.65
48.	REJ	1.64	2.88	1 3822	1 1071	3.50
49.	CON	1.16	2 68	0 4630	1.1565	6 10
50.	CRS	2.92	1.36	1 2937	1 2290	4.37
51.	COE	3 88	3.12	0 3250	1.0703	3 40
52.	ACC	3.24	1.08	1 0688	0 6882	8 50
53.	CRS	3.16	1.08	0.8800	1 0925	7.41
54.	PER	3 40	2.44	0.8944	1 4165	2.87
55.	REJ	2.04	3.12	1.2484	1.0703	3.28
56.	CON	1.60	3 16	1 2000	1.1200	5.99
57.	CRS	2.52	1.44	1 5778	1 0229	2 87
58.	COE	3.68	2.44	0 4665	1.2027	4.81

1	2	3	4	5	6	7
59	ACC	3 32	1.60	0.7332	1.0583	6.68
60.	CRS	3 24	1.52	0.9912	1 0998	4.81
61	PER	2.56	1.08	1.2674	0.8908	4.78
62	REJ	2.04	3.68	1.3705	0.4665	5.66
63.	CON	1.88	3.20	0.9516	1.2961	4.11
64.	CRS	3.48	1.60	0.6400	1.0954	7.41
65.	COE	2.72	1.12	1.1143	0.9516	5 46
66.	ACC	3.04	0.76	0 8237	0.8139	9.85
67	CRS	3.28	0.64	0.9600	0.9749	9.65
68.	PER	3 44	2 24	1.6020	1 2093	2 99
69.	REJ	1.20	2.68	1.2961	1.4063	3.87
70	CON	1 36	2.96	0.5571	1.2800	5.73

1. I. N · serial number of the item in the final form of inventory
2. Dimensions (or aspects) of School Environment : (1) 'CRS'= Creative Stimulation; (2) 'COE'=Cognitive Encouragement ; (3) 'ACC'=Acceptance ; (4) 'PER'=Permissiveness ; (5) 'REJ'= Rejection ; (6) 'CON'= Control
3. 'UCG'=Upper Criterion Group
4. 'LCG'=Lower Criterion Group

5. 2. 3. *The Final Form*

The School Environment Inventory, in its final form, has seventy items arranged in a random manner Items 1, 4, 8, 11, 15, 18, 22, 25, 29, 36, 39, 43, 46, 50, 53, 57, 60, 64 and 67 measure 'Creative Stimulation (CRS) ; items 2, 9, 16, 23, 30, 37, 44, 51, 58 and 65 measure 'Cognitive Encouragement' (COE), items 3, 10, 17, 24, 31, 38, 45, 52, 59 and 66 measure 'Acceptance' (ACC) , items 5, 12, 19, 26, 33, 40, 47, 54, 61, 68 measure 'Permissiveness' (PER) ; items 6, 13, 20, 27, 34, 41, 48, 55, 62 and 69 measure 'Rejection' (REJ) while 'Control' (CON) in school environment is measured by items 7, 14, 21, 28, 35, 42, 49, 56, 63 and 70.

5. 2. 4 *Reliability of the Inventory*

The inventory in its final form was administered to 54 boys studying in intermediate science classes in three schools, *viz.* Christian Inter College Mainpuri ; Government Inter College, Mainpuri and St John's Inter College, Agra and 59 girls studying science in XI and XII classes in Murari Lal Girls' Inter College, Agra and Queen Victoria Girls' Inter College, Agra.

The split-half reliabilities were worked out for all of the six dimensions separately using product moment coefficient of correlation. The resulting coefficients of correlation between the two subdivided tests for each of the dimensions were boosted up using Spearman Brown Prophecy formula These reliability indices are as follows :

Table 5. 3 *Split-half reliabilities for school environment inventory*

S N.	Inventory Dimension	Reliability Coefficient
1.	Creative Stimulation	·91968
2.	Cognitive Encouragement	·79704
3.	Acceptance	·82299
4.	Permissiveness	·67284
5.	Rejection	78094
6.	Control	·76166

5 2. 5. *Validity of the Inventory*

Content validity is considered to be of great importance. Hence efforts were made to get this inventory judged by a number of persons, experts and administrators. The inventories along with operational definitions of various aspects of school environment were given/sent to these individuals to read and to judge whether each item within the inventory measures the dimension indicated against it or not. They were also requested to report the extent to which six dimensions of 'School Environment' as measured through seventy items are representative of the total hypothesized environment area. The author was satisfied when two principals, one administrator (S D.I), ten experts and 14 teachers expressed the opinion that the items are measuring the characteristics indicated by the respective dimensions. Thus, the face or content validity of the inventory was scrutinized to make the inventory as dependable as possible.

As it was planned to measure a single common factor 'Stimulation in the School Environment' through this inventory, it was considered worthwhile to compute 'Intrinsic Validity'. Guilford thinks the degree to which a test measures what it measures may be called its intrinsic validity. He defined it also in terms of how well the obtained scores measure the test's true score components Product moment coefficients of correlation were worked out between individual's total score on the inventory and on various dimensions (Table 5.4).

Table 5. 4 *Correlations beween dimension score and total scores*

S.N.	Dimension	Correlation with total score
1.	Creative Stimulation	88016*
2.	Cognitive Encouragement	·75227*
3.	Acceptance	23253*
4	Permissiveness	·590207*
5	Rejection	·20315**
6.	Contiol	·52859*

N=135 (60 boys and 74 girls)

* Significant at ·01 level

** Significant at ·05 level

Pursual of table 5·4 shows that all correlations are significant. This indicates that School Environment Inventory possesses intrinsic validity

Construction and Standardization of Home Environment Inventory

Home itself is a complex unit The assessment of its psychosocial environments is not an easy matter. This is due to the complexity of the phenomenon under investigation, the number of possible approaches that can be taken and the conceptual and methodological difficulties within each approach. Though Fraser (1959), Yarrow and Goodwin (1965) and Wright (1967) laid emphasis on adequate observation and recording of behaviours in naturally occurring environments, we think the observation of parental child-rearing behaviours will not yield reliable and valid data. The reasons for unreliability and less validity of the information gathered by observers are (1) less time for observation, (2) effects of the presence of external observers on the child being treated and on his parents, (3) the phenomenon of observer drift, and (4) observer's expectation. Powell, Martindale and Kulp (1975) showed that methods of recording can result in underestimation or overestimation of behaviour occurring.

Sears, Maccoby and Levin (1957) and Davis and Havighurst (1943) used interviews to assess parental childrearing practices while Wolf (1966), Marjoribanks (1972) and Joshi and Tiwari (1977) constructed interview schedules for the same purpose. Other significant tools for measuring parental attitudes toward childrearing have been constructed by Stogdill (1933), Shoben (1948), Schaefer and Bell (1958), Freeberg and Payne (1967), Kawash (1968), Gibson (1968), Sidana and Sinha (1973), Melrose (1974), Husaini (1975) and Kilman (1975) However, Serot and Teevan (1961) thought that there appears be too little agreement between parental perceptions of the parent-child relationships and the child's perception of it. Moreover, it is child's perception of his parent's behaviours that determines his behaviours. Thinking about the direction that future research in the area should take, Hawkes (1963) suggested that the crux of parent-child relations as far as the child

in the family is concerned appears to be in the area of childrens's perception of what the parents are, rather than in very definite and specific characteristics of home life Some of the important tools designed to measure children's perception of their home environments were reviewed

6. 1 Review of Tools

Bronfenbrenner (1961) constructed a 'Parent Behaviour Questionnaire' to tap child's perception of the parent on a number of 15 dimensions, *viz.* nurturance, affective reward, instrumental companionship, affiliative companionship, prescriptive, social isolation, expressive rejection, physical punishment, deprivation of privileges, protectiveness, power, achievement demands, affective punishment, principled discipline and indulgence

Mitchell (1963) constructed a fourteen item multiple choice inventory on perceptions of self, family and self-within family. Its items not only represent aspects of family life and family interrelationships but also cover aspects of the subjects' greater motivational orientation. A factor analysis of inventory revealed existence of three factors, *viz* satisfaction with family life, academic motivation and meeting parental standards.

Grebow (1973) constructed a 'Parent Rating Scale' to judge mother-daughter and father-daughter relationships along the two dimensions-general affective relationship, and achievement demands and valuation. The subject is asked to make a judgment about her parent's attitudes as she perceived them, even though they were not always expressed directly.

Armentrout (1975) collected students' responses on a revised form of the 'Child's Report of Parental Behaviour' It measures parental rejection and control.

Angenent (1976) derived two questionnaires from P. E. Slater's 'Parental Role Pattern Questionnaire' to measure how children perceive their upbringing. These questionnaires consist of 18 items each and two dimensions, *viz.* warmth and dominance constitute a dimensional circumplex

Scheck and Emerick (1976) constructed a questionnaire which provides information about children's perception of parental supportiveness and consistency

Thus, it is apparent that measurement of children's perception of their home environment has attracted the attention of psychologists in various fields. However, the above mentioned tools are not culture fair This makes them unsuitable for use in the Indian context and emphasizes the

importance of constructing a tool to measure children's perception of their home environment.

6. 2. Construction and Standardization of Home Environment Inventory

6. 2. 1 *Construction of Items*

After having selected and defined the dimensions of children's perception of their home environment, twenty to twenty five items were written initially to measure the predetermined aspects of home environment Each of these items was read and judged five times on different occasions by the present investigator. As a result of these efforts some items were reworded each time while some that were considered to be irrelevant, were dropped. The resulting pool of items consisted of about twelve to twenty items under each dimension. These items were typed and subjected to expert scrutiny The typed inventory was discussed with two experts and fifteen fathers engaged in different types of occupational activities, *viz.* medical, clerical, collegiate teaching, school teaching and business, and some reseachers interested in the inventory The operational definitions were also presented to them and they were requested to judge whether each item measures that dimension of home environment which it intended to measure. Their opinions about irrelevant or doubtful items were noted by the researcher and the items were modified in consultation with them Irrelevant items which could not be modified to suit the desired objective were dropped The preliminary form was rewritten with the help of carbon paper and the inventory was administered to 40 students of XI Class of Christian Inter College, Farrukhabad The responses were analysed to explore their applicability. The situations in which students responded to various items were carefully observed to detect language-difficulties of children Some students expressed difficulty in undrstanding a few words The meanings of these words were explained to them Only one item containing such words was reworded. The inventory now consisted of ten dimensions each with twelve to sixteen items representing the dimension. This inventory was got printed along with the necessary instructions for students'.

6 2 2. *Item Analysis*

The preliminary form of the inventory was administered to 127 students studying in XI and XII classes of five randomly selected schools situated in Mainpuri, Farrukhabad and Kanpur cities. Observation of the test papers showed that seventeen students did not respond to one or more items Sheets of such students were separated and the remaining 110 sheets were used for item analysis,

These sheets were scored using O-4 marks O,1,2,3 and 4 marks were assigned to 'Mostly', 'Often', 'Sometimes', 'Least' and 'Never' response categories respectively in case of seven dimensions, *viz.* 'control', 'Conformity', 'Rejection', 'Punishment', 'Protectiveness', 'Social Isolation', and 'Deprivation of Privileges' This scoring pattern was reversed in case of responses belonging to three dimensions of the inventoiy, *viz.* 'Permissiveness', 'Nurturance', and 'Reward'.

After having scored various items of 110 sheets, scores sobtained by each individual on various items belonging to specific dimensions were added together to yield ten composite scores on ten dimensions of the 'Home Environment Inventory' The sheets were arranged in an ascending order of scores with the lowest score on a specific dimension at the bottom and the highest composite score at the top. This process was repeated ten times for ten dimensions separately and each time thirty (27 per cent of 110) sheets were selected from eithei ends of the ordered sheets. These sheets represented the individuals in upper and lower criterion groups. Upper/lower limits of scores of individuals selected in these groups (UCG and LCG) have been shown in table 6.1

Table 6. 1 *Cut-of points for upper and lower criterion groups for various diemnsions*

S. N.	Dimensions	Cut-off score points	
		UCG	LCG
1	Permissiveness	50	40
2.	Nurturance	55	49
3	Reward	64	54
4.	Control	30	40
5.	Conformity	10	18
6	Rejection	16	33
7.	Punishment	12	20
8.	Protectiveness	23	33
9	Social Isolation	28	48
10	Depiivation of Privileges	26	33

Using students' scores on different items, t-ratios were calculated to find out discrimination value for each item of every dimension of home environment. Ten items with highest t-values were retained for the final form for inclusion under each of the ten dimensions of home environment as perceived by the subjects. All of these t-values (given in table 6.2) except four were significant at 01 level. Thus, hundred items could be selected for ten dimensions The sequence in which items belonging to various dimensions were to appear in the final form was determined through random selection.

Table 6.2 *Mean, standard deviations and t-values for items included in the final form of home environment inventory*

I.N $_1$	Dimen sion$_2$	Mean Scores		Standard Deviations		t-ratio
		UCG$_3$	LCG$_4$	UCG	LCG	
1	2	3	4	5	6	7
1.	CON	1.13	2.17	1.1619	1.2490	3.35
2.	PRO	1.03	3.00	1.1000	1.1533	6.79
3.	PUN	0.17	1.97	0.4123	0.6708	12.50
4.	COY	0.73	1.80	1.0677	1.7493	2 89
5.	SOI	2.33	3.83	1.2923	0 3606	6.25
6.	REW	3.77	2.63	0.7416	1.3379	4.07
7.	DEP	1.20	2.93	1.1358	1 1790	5 96
8.	NUR	2 90	1 50	1.2728	1.8028	3.50
9.	REJ	2.27	3 47	1.5330	1.1225	11.01
10.	PER	3 10	2.27	0 8700	1.0200	3.32
11.	CON	0.53	1.90	1.1045	1.5780	3 91
12	PRO	0.53	2 00	0.7874	1.4595	4.90
13.	PUN	0.53	2.73	0.7874	1.1747	7.36

1	2	3	4	5	6	7
14.	COY	0.17	1.67	0.4123	1.3820	5.77
15.	SOI	2.27	3.53	1.8303	0.9539	3.32
16.	REW	2.70	1.17	1.3191	1.2329	4.63
17.	DEP	2 17	3.17	1.2490	1.0724	3.33
18.	NUR	1.90	0.77	1.3266	0.9849	3.77
19.	REJ	3.20	3.90	1.1091	0.3000	3.33
20.	PER	1.23	0.23	1.4595	0.7681	3.33
21.	CON	0.83	2.17	1.1136	1.5362	3.83
22.	PRO	0.77	2.53	1.0392	1.4036	5.50
23.	PUN	0.53	2.53	1.0909	0.9849	7.41
24.	COY	0.33	1.53	0.6245	1.3528	4.07
25.	SOI	1.87	2 53	1.4491	0.4359	4.89
26.	REW	3.70	2.33	0.4583	0.2828	10.64
27.	DEP	2.37	3.53	1.6673	0.8426	3.41
28.	NUR	2.43	1.07	1.1576	1.3601	4.25
29	REJ	2.80	3.70	1 4248	0.8246	2.95
30.	PER	2 10	0.67	1.2207	0.9695	5.11
31.	CON	1.80	3.53	1.7776	1.1446	4.48
32.	PRO	0 17	1.23	0.4123	1.3000	4.24
33.	PUN	0.10	1.53	0.3000	1.4697	5.11
34	COY	0.73	2.30	0.4123	1.5297	5.41
35.	SOI	1.90	3.30	1.2490	1.0392	4 83
36.	REW	3.60	1.60	0.5568	1.2000	8.33
37	DEP	2.03	3.50	1.1000	0.7211	6.12
38.	NUR	1.20	0.33	1.4457	0.8718	2.81

1	2	3	4	5	6	7
39.	REJ	0.63	2.43	0.7746	1.5166	5.82
40.	PER	3.33	0.90	1.1180	1 4000	7 36
41.	CON	2.43	3.50	1.5395	1.0863	3 13
42.	PRO	0.77	2.40	0 9695	1.4036	5 25
43.	PUN	0.00	1.63	0 0000	1.5524	5.62
44.	COY	0 37	1 43	0 8124	1.6823	3.12
45.	SOI	2 10	3.50	1.2806	0.8485	5.00
46.	REW	2.77	1.43	1 4799	1.4142	3.62
47	DEP	2 00	3 17	1.2124	1.3115	3.65
48.	NUR	2 10	0.90	1.6401	0 8718	3.53
49.	REJ	3 27	3.93	1.1576	0.2449	3.05
50.	PER	1.63	0.23	1.3342	0 1782	5.20
51.	CON	2.33	3.63	1.5067	1.3229	3.51
52.	PRO	1.37	3.20	1.4318	1.0440	5.09
53	PUN	1.53	2.60	1.7000	1.3565	2.69
54.	COY	0 37	1.50	0 6782	1.1180	4.71
55.	SOI	2 20	3.67	1.2490	0.7483	5.44
56	REW	3.90	3.17	0.3000	0 6084	6.29
57	DEP	2.33	3.10	1.5492	1 3000	2.08
58.	NUR	2.97	1.20	1.1269	1 3266	5 53
59.	REJ	1 83	3.40	1 0247	1 6462	4.48
60.	PER	2.03	0.37	1.2329	0.9055	5.93
61.	CON	1 97	3.27	1.3964	1.4177	3.61
62.	PRO	1.67	3 50	1.5199	0.9592	5.55
63.	PUN	0 40	1.87	0.5568	1 4832	5.07

1	2	3	4	5	6	7
64.	COY	0.33	2.07	1.1225	1.5330	5.12
65	SOI	1.90	3 50	1.4071	0.9899	5.16
66.	REW	3.57	1.37	0.4690	1.1874	9 57
67.	DEP	1.83	3 70	1 3115	0.6403	6.92
68	NUR	3.53	1.77	0.7416	1.4248	6.09
69.	REJ	3.00	3.90	1 0954	0.3000	4.35
70.	PER	2.93	1.73	0.9110	1.1619	4 44
71	CON	2.53	3.30	1 4036	1.0050	2.41
72.	PRO	1.83	3 33	1 7088	1.1576	4.05
73.	PUN	0.87	2 23	0.9695	1.3038	4.59
74.	COY	0.17	0.97	0.5196	1.2884	3.20
75.	SOI	2.10	3.47	1.4213	0.4359	5.08
76.	REW	3 73	2.30	0.4796	1.3454	5.50
77.	DEP	2.20	3.63	1.1358	0.5000	5.22
78.	NUR	3.20	1 07	0.7000	1.1790	8.52
79.	REJ	0.30	1 77	0.6403	1.7889	4.23
80.	PER	1.93	0.43	1.3491	1.1358	4.69
81	CON	2.47	3.57	1 2923	0.7681	4 08
82.	PRO	0.80	1 87	1 1358	1.5067	3.69
83,	PUN	0.03	1 80	0.0000	1.5133	6.56
84.	COY	0.43	1.13	0 9434	1.2207	2.50
85.	SOI	2.33	3.73	1 2247	0.4359	6 36
86.	REW	3.53	1 77	0.5292	0.9487	8.86
87.	DEP	1.90	3.30	1.3748	1.2166	4.11
88.	NUR	2.20	0.67	1 6217	1.0392	4.37

1	2	3	4	5	6	7
89.	REJ	0.37	2.87	0.6782	1.6703	7.57
90	PER	1.40	0 17	2.2293	0.3606	3.00
91.	CON	1.30	2.90	1.5524	1.4900	4.10
92.	PRO	1.80	3.20	1.2767	1.6823	3 59
93.	PUN	0.07	1.33	0.3162	1.3892	4 85
94.	COY	1.87	3.27	1.7321	1.3191	3.50
95.	SOI	2.00	3 37	1.4123	1.0536	4 28
96.	REW	3.77	2.03	0 3873	1 1790	7.69
97.	DEP	1.80	3.43	0.1732	0 9539	9.05
98.	NUR	3.80	3 27	0 6325	1.0488	2 41
99.	REJ	3.27	3.80	1.0050	0.4796	2.61
100.	PER	2.70	1.00	1 1314	1.4832	5 00

1 I. N.. Serial number of item in the final form of HEI
2. Dimensions (or Aspects) of Home Environment : CON=Control, PRO=Protectiveness, PUN=Punishment, COY=Conformity, SOI=Social Isolation ; REW=Reward; DEP=Deprivation of Privileges , NUR=Nurturance ; REJ=Rejection ; and PER=Permissiveness
3. UCG=Upper Criterion Group
4. LCG=Lower Criterion Group.

6.2.3. *The Final Form*

The 'Home Environment Inventory' in its final form has one hundred items arranged in a random manner Items 1, 11, 21, 31, 41, 51, 61. 71, 81 and 91 belong to the dimension of 'Control' , items 2, 12, 22, 32, 42, 52, 62, 72, 82 and 92 belong to the dimension of 'Protectiveness' , items 3, 13, 23, 33, 43, 53, 63, 73, 83 and 93 belong to the dimension of 'Punishment' ; items 4, 14, 24, 34, 44, 54, 64, 74, 84, and 94 belong to the dimension of 'Conformity' ; items 5, 15, 25, 35, 45, 55, 65, 75, 85 and 95 belong to the dimension of 'Social Isolation' ; items at no. 6, 16, 26, 36, 46, 56, 66, 76, 86 and 96 represent the dimension of 'Reward' , items 7, 17, 27, 37, 47, 57, 67, 77, 87, and 97 have been designed to measure Deprivation of Privileges' , 'Nurturance' is to be measured through items 8, 18, 28, 38, 48, 58, 68, 78, 88 and 98 ; items 9, 19, 29, 39, 49, 59, 69, 79, 89 and 99 belong to the dimension of 'Rejectiou' while items at no. 10, 20, 30, 40, 50, 60, 70, 80, 90 and 100 represent the 'Permissiveness' dimension of the home environment.

6.2.4. *Reliability of the HEI*

The inventory in its final form was administered to 113 students including 54 boys and 59 girls studying in the intermediate science classes in five schools.

The split half reliabilities were worked out separately for all the ten dimensions of the home environment inventory. Product moment coefficients were computed and the resulting correlations between the two subdivided tests for each dimension were boosted up using Spearman Brown Prophecy formula. The reliability indices are as follows .

Table 6 3 *Split-half reliabilities for various scales in HEI*

S.N.	Aspects of home environment	Split-half reliability
1.	Control	.87856
2.	Protectiveness	.74819
3.	Punishment	.94686
4.	Conformity	.86612
5.	Social Isolation	.86996
6.	Reward	.87522
7	Deprivation of Privileges	.85494
8.	Nurturance	90131
9.	Rejection	.84071
10.	Permissiveness	.72552

6 2 5. *Validity of the HEI*

Content validity of the Home Environment Inventory was very carefully scrutinized to make the inventory as dependable as possible. For this HEIs along with the operational definitions of various dimensions of Home Environment were given/sent to ten parents and experts to read and to judge whether each item designed to measure a particular dimension of home environment measures what it intends to measure The dimensions were indicated against each item. The judges were also requested to report the extent to which this inventory will measure the total hypothesized environment area. The author was satisfied when all of the seven parents and ten out of fifteen experts expressed the opinion that the items are measuring the characteristics indicated by the respective dimensions.

Intrinsic validity was also computed by correlating scores obtained on various dimensions with the scores obtained on the inventory. Product moment coefficients of correlation were worked out using responses of 134 students including 60 boys and 74 girls studying science in five schools Values of these correlations are given in table 6.4. They point to the intrinsic validity of the tool.

Table 6.4 *Correlations between dimension scores and total scores on HEI*

S. N	Dimension	Correlation
1.	Control	.39978
2	Protectiveness	.15813
3.	Punishment	.58200
4.	Conformity	.43122
5	Social Isolation	.73698
6.	Reward	25169
7.	Deprivation of Privileges	.65377
8	Nurturance	40374
9	Rejection	.52073
10.	Permissiveness	.44710

Criterion related validity involves correlation between scores on the test and scores on some other pure criterion measure of the constructs which the subtest intends to measure No trait exists as 'an ideal quantity' independent of any operational definition. Ebel has pointed out that construct validation is a meaningless concept as the criteria are never precise and perfect. According to him the validity of a test is not determined unless the validity of the criterion has been determined, which requires a criterion for the other criterion, and so on adinfinitum. He is of the view that if test provides, in itself, the best available operational definitions, the concept of validity does not apply. A basic definition needs to be meaningful, but it does not need to be, and it indeed cannot be validated. Exactly the same view has been expressed by Atkinson "Validity in the sense of comparing one response measure against another better one is meaningless for motivation research because there is no better measure" Author has not calculated criterion-related validity because of the lack of valid criteria.

Sex Differences in Scientific Creativity

It is a well known fact that very few Indian women have achieved eminence as scientific discoverers or inventors Torrance's (1963) experiments show that in the early school years girls develop attitudes, interests, and even disabilities that make it difficult for them to become scientific discoverers and inventors However, the author has observed that girls enjoy performing tasks that require creative scientific thinking. As compared to boys, girls (who constituted samples for the present investigation) showed active interest in responding to items on the 'Tests of Scientific Creativity' This observation aroused the curiosity to investigate whether sex variable plays any significant role on the development of scientific creativity.

It is a fact that no two persons, except the identical twins, are likely to have identical genotypes (*i.e.* the genetic constitution). It is to be believed that boys differ from girls in their genotype According to Sinnott, et al. (1976) the phenotype (*i e.* the appearance of the organism =the sum total of all its characteristics) of any organism is necessarily a result of the interaction of a genotype with an environment Thus, both the genotype and the environment are necessary for the development of scientific creativity. It, therefore, appears reasonable to hypothesize that sex differences occur in scientific creativity Testing of this hypothesis demanded formation of equivalent groups First of all verbal and non-verbal intelligence scores as obtained by boys and girls, were compared to avoid bias of intelligence among the two groups

7 1 Comparison of Nonverbal Intelligence among Boys and Girls

In order to find out whether the two groups under study are similar in respect of their nonverbal intelligence students' scores on the culture fair test of intelligence were taken into consideration and the Kolmogorov-Smirnov two sample test was used to analyse the scores Table 7 1 shows that the calculated value of D is .1393 This must equal or exceed the D

Table 7 1 *Comparison of nonverbal intelligence of boys and girls*

C I	f_b	f_g	Cum f_b	Cum f_g	$S_{95b}(X)$	$S_{102g}(X)$	$\mid S_{95b}(X)-S_{102g}(X) \mid$
32-33	1	0	95	102	1 0000	1 0000	0.0000
30-31	1	1	94	102	9895	1 000	.0105
28-29	0	4	93	101	.9790	9902	.0112
26-27	1	5	93	97	.9790	9510	0280
24-25	7	6	92	92	.9684	9020	0664
22-23	11	15	85	86	.8947	8431	.0516
20-21	15	19	74	71	.7790	6961	.0829
18-19	14	17	59	52	.6211	5098	.1113
16-17	15	17	45	35	4736	3431	.1305
14-15	12	6	30	18	.3158	1765	1393*
12-13	6	7	18	12	1895	1177	.0718
10-11	8	3	12	5	.1263	0490	.0773
8-9	2	2	4	2	0421	.0196	.0225
6-7	1	0	2	0	.0211	0000	.0211
4-5	1	0	1	0	0105	0000	0105

* D—value

value of .1938, in order to enable us to reject H_0 at .05 level. The computed value of D is less than the critical value of D. Hence, the null hypothesis of no significant difference in the intelligence of boys and girls is acceptable. In other words, our sample subjects belonging to the two sexes do not differ with respect to their nonverbal intelligence. Now, we will explore whether these two groups of boys and girls differ with respect to scores on Jalota's Test of Mental Ability.

7 2. Sex Differences in Verbal Intelligence

Table 7.2 *Sex differences in verbal intelligence*

C I.	f_b	f_g	Cum f_b	Cum f_g	$S_{95b}(X)$	$S_{102g}(X)$	$\lvert S_{95b}(X)-S_{102g}(X) \rvert$
95-99	1	1	95	102	1 0000	1.0000	.0000
90-94	8	14	94	101	9895	.9902	0007
85-89	13	7	86	87	9053	.8529	.0524
80-84	7	16	73	80	7684	7843	.0159
75-79	5	16	66	64	.6947	6275	.0672
70-74	12	14	61	48	6421	.4706	1715
65-69	3	9	49	34	.5158	3333	1825
60-64	9	10	46	25	.4842	2451	.2391
55-59	10	4	37	15	.3895	1471	2424
50-54	11	4	27	11	.2842	.1078	.1764
45-49	4	6	16	7	1684	.0686	0998
40-44	5	1	12	1	1263	.0098	1165
35-39	6	0	7	0	0737	0000	0737
30-34	1	0	1	0	0105	.0000	0105

* D—value

Observation of table 7.2 shows that the calculated value of D is 2424, being the largest discrepancy between the two series of observed cumulative step functions of the two samples Critical D values were calculated with the help of formulae given in table M in Siegel's *Nonparametric Statistics* By computation it was found that our D value must be .1938, .2323, .2779 or larger for H_0 to be rejected at 05, 01, or 001 level of significance respectively The calculated D value (=.2424) is greater than .2323 (D-value required for testing significance at .01 level). Hence, H_0 stands rejected at 01 level of significance. It means that verbal intelligence scores of boys are significantly lower than those of girls In other words sex differences exist in verbal intelligence among the sample subjects.

This finding may be quite disturbing but it does not challenge the established fact of no sex difference The difference is in respect of the present sample When we give a serious thought to the nature of boys and girls who seek admissions to the science courses, the answer becomes apparent. Usually, only those girls who are confident of their ability to understand science and their capacity to work hard opt for the science courses. Their family atmosphere compels them to take such a decision. As a result of this attitude of parents as well as girls, it is possible that intelligent girls decide to study science Such a decision making is not usual in the case of boys Aspirations of parents to see their sons as doctors or engineers usually guide the decision making process of boys It is immaterial whether a boy is able to understand science or not. Even boys with no capacity to work hard and understand the basic scientific concepts are allowed to sudy science In view of such conditions, it is not surprising to find that girls are more intelligent than boys.

Now a question arises in our brain. Why do girls not excel boys in nonverbal intelligence ? The answer may be hunched either in the cultural context or in the number of items in the culture fair test of intelligence. These unusual findings called for formation of equivalent groups.

7 3. Formation of Equivalent Groups

Table 7 3 *Sex differences in nonverbal intelligence (for equivalent groups)*

C I.	f_b	f_g	Cum f_b	Cum. f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\lvert S_{69b}(X)-S_{69g}(X) \rvert$
32-33	1	0	69	69	1 0000	1 0000	0.0000
30-31	1	1	68	69	.9855	1.0000	0 0145
28-29	0	1	67	68	9710	.9855	0.0145
26-27	1	3	67	67	9710	.9710	0 0000
24-25	5	2	66	64	9565	.9275	0 0290
22-23	9	12	61	62	.8841	8986	0.0145
20-21	13	11	52	50	.7536	7246	0.0290*
18-19	11	13	39	39	5652	.5652	0.0000
16-17	12	10	28	26	.4058	.3768	0 0290
14-15	6	6	16	16	.2319	2319	0 0000
12-13	5	6	10	10	.1449	.1449	0 0000
10-11	3	3	5	4	0725	.0580	0 0145
8-9	2	1	2	1	.0290	0145	0 0145

*D—Value

While forming equivalent groups, matching was done initially by pairs so that each boy in the first group has a match in the second group Differences between verbal as well as nonverbal intelligence scores of individuals in a matched pair ranged from +3 to -3 After forming such equivalent groups, efforts were made to ensure that the two groups are really equivalent. To achieve this objective, Kolmogorov-Smirnov Two Sample Test was used

Table 7 4 *Sex differences in verbal intelligence (for equivalent groups)*

C I	f_b	f_g	Cum f_b	Cum f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\mid S_{69b}(X)-S_{69g}(X) \mid$
94—98	2	3	69	69	1 0000	1 0000	0000
89—93	8	8	67	66	9710	9565	0145
84—88	12	10	59	58	8551	·8406	·0145
79—83	5	6	47	48	6812	6957	0145
74—78	5	7	42	42	6087	6087	0000
69—73	12	9	37	35	5362	5072	0290
64—68	4	4	25	26	3623	3768	·0145
59—63	7	8	21	22	3043	3188	0145
54—58	6	3	14	14	2029	2029	0000
49—53	5	8	8	11	·1159	1594	0435
44—48	3	3	3	3	0435	·0435	·0000

* D value

Observation of tables 7 3 and 7 4 reveals that the calculated D values are .0290 (for nonverbal intelligence) and 0435 (for verbal intelligence) These calculated values of D must equal or exceed the critical D value (= 2312, .2775, or 3320, computed with the help of formulae given in table M in Siegel's book) in order to enable us to reject the null hypotheses at ·05, .01 and 001 levels respectively Our D values(=.0290 and .0435) are less than .2312 and therefore the null hypotheses that boys do not differ from girls with respect to their verbal/nonverbal intelligence stand accepted It means that the two groups are equivalent with respect to verbal as well as nonverbal intelligence Now the scientific creativity scores of these boys and girls were used for exploring sex differences in scientific creativity Data has been analysed with the help of the Kolmogorov-Smirnov two-sample test

7 4. Differences in the Overall Scientific Creativity of Boys and Girls

Table 7. 5 *Differences in the scientific creativity scores of boys and girls*

C I.	f_b	f_g	Cum f_b	Cum. f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\lvert S_{69b}(X)-S_{69g}(X)\rvert$
238—252	0	1	69	69	1 0000	1 0000	0 0000
223—237	0	0	69	68	1.0000	.9855	0 0145
208—222	2	3	69	68	1.0000	.9855	0.0145
193—207	2	5	67	65	.9710	.9420	0.0290
178—192	3	5	65	60	9420	.8696	0.0724
163—177	1	6	62	55	8986	.7971	0.1015
148—162	4	7	61	49	.8841	7101	0.1740
133—147	6	5	57	42	.8261	6087	0.2174
118—132	4	7	51	37	.7391	.5362	0.2029
103—117	6	16	47	30	6812	.4348	0 2464
88 – 102	13	9	41	14	5942	.2029	0 3913*
73—87	14	3	28	5	.4058	0725	0.3333
58—72	6	2	14	2	.2029	.0290	0.1739
43—57	6	0	8	0	.1159	0.0000	0 1159
28—42	2	0	2	0	.0290	0 0000	0.0290

* Dvalue

Observation of table 7 5 shows that the largest discrepancy between the two series of observed cumulative step functions of the two samples is .3913 (=D value) This calculated value is larger than the critical value (= 3320) required for significance at 001 level Thus, the null hypothesis of 'no significant difference in scientific creativity among boys and girls' stands rejected It means that girls excel boys in scientific creativity, as judged by the 'Tests of Scientific Creativity' developed by the author. Similar findings have been reported by Yamamoto (1960), Neufeld (1964), Razik (1964), Dauw (1966), Littlejohn (1967), Solomon (1968), Ogletree (1968), Fletcher (1968), Bowers (1971) and Rodrigues & Soriano de Alencar (1983) Kelley (1965), Prakash (1966), Raina (1968, 1969), Middents (1968), Straus and Straus (1968) and Gagneja (1972) have found that boys are more creative than girls. Torrance (1962) has aptly remarked, "That boys excel girls, and girls boys in different kinds of creative activity has been one of the most consistent findings about creative thinking during the past sixty or seventy years "

7 5 Differences in Scores on Various Aspects of Scientific Creativity among Boys and Girls

Analysis of data on overall scientific creativity scores has revealed excellence of girls Now let us further probe and try to see whether girls excel boys in various aspects of scientific creativity, *viz* fluency, flexibility, originality and inquisitiveness

Table 7 6 *Differences in scores obtained by boys and girls on fluency aspect of scientific creativity*

C. I	f_b	f_g	Cum. f_b	Cum. f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\lvert S_{69b}(X)—S_{69g}(X) \rvert$
62—66	0	1	69	69	1.0000	1 0000	0 0000
57—61	0	0	69	68	1 0000	.9855	.0145
52—56	0	5	69	68	1 0000	.9855	0145
47—51	2	7	69	63	1.0000	.9130	0870
42—46	6	10	67	56	9710	.8116	.1594
37—41	4	9	61	46	8841	.6666	.2175
32—36	10	11	57	37	8261	.5362	.2899
27—31	10	12	47	26	6812	3768	3044
22—26	13	10	37	14	5362	2029	.3333*
17—21	16	4	24	4	3478	0580	.2898
12—16	7	0	8	0	.1159	0 0000	.1159
7—11	1	0	1	0	0145	0.0000	0145

* D-value

Table 7 6 shows that the calculated value of D is 3333. This value is significant at .001 level. Thus, there exists significant difference in

fluency aspect of scientific creativity among boys and girls It means that as compared to boys, girls are higher on fluency aspect of scientific creativity. Guilford (1964), Dhir (1973) and Goyal (1973) have reported similar findings in case of fluency aspect of general creativity.

Table 7 7 *Comparison of scores obtained by boys and girls on flexibility aspect of scientific creativity*

C. I.	f_b	f_g	Cum f_b	Cum. f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\mid S_{69b}(X)-S_{69g}(X) \mid$
39—41	0	2	69	69	1 0000	1 0000	0 0000
36—38	1	6	69	67	1 0000	0 9710	0 0290
33—35	5	9	68	61	0.9855	0 8841	0 1014
30—32	3	7	63	52	0 9130	0 7536	0.1594
27—29	4	3	60	45	0 8696	0 6522	0 2174
24—26	9	12	56	42	0.8116	0.6087	0 2029
21—23	5	15	47	30	0 6812	0.4348	0 2464
18—20	16	9	42	15	0.6087	0.2174	0 3913*
15—17	16	5	26	6	0 3768	0.0870	0 2898
12—14	6	1	10	1	0.1449	0 0145	0 1304
9—11	3	0	4	0	0 0580	0 0000	0 0580
6—8	1	0	1	0	0 0145	0 0000	0 0145

* D value

Observation of table 7 7 reveals that the calculated value of D is 3913. This value is significant at .001 level and the null hypothesis of no significant difference in flexibility aspect of scientific creativity among boys and girls stands rejected. This means that girls excel boys on flexibility, an aspect of scientific creativity

Table 7.8 *Comparison of scores obtained by boys' and girls on originality aspect of scientific creativity*

C. I.	f_b	f_g	Cum. f_b	Cum. f_g	$S_{69}b(X)$	$S_{69}g(X)$	$\lvert S_{69}b(X)-S_{69}g(X) \rvert$
136—145	0	1	69	69	1.0000	1.0000	0.0000
126—135	2	0	69	68	1.0000	.9855	0145
116—125	0	3	67	68	.9710	.9855	.0145
106—115	2	3	67	65	9710	.9420	.0290
96—105	2	6	65	62	.9420	8986	.0434
86—95	1	6	63	56	.9130	.8116	1014
76—85	4	8	62	50	8986	.7246	1740
66—75	7	8	58	42	.8406	.6087	.2319
56—65	4	7	51	34	.7391	.4928	.2463
46—55	11	16	47	27	.6812	3913	.2899
36—45	17	6	36	11	5217	.1594	.3623*
26—35	10	5	19	5	.2754	0725	.2029
16—25	6	0	9	0	.1304	0.0000	.1304
6—15	3	0	3	0	.0435	0 0000	0435

* D value

Table 7.8 shows that the calculated value of D is .3623. It is significant at 001 level. It means that the null hypothesis of no significant difference in originality, an aspect of scientific creativity, among boys and girls is to be rejected Our decision to reject H_0 implies that girls excel boys on originality aspect of scientific creativity. MacGregor and Smith (1965), Harlow (1967) and Hussain and Hussain (1975) have found that girls excel boys in originality.

Examination of table 7.9 shows that the calculated D-value is .1449. This value is less than the critical value ·2312 (for ·05 level). Hence, this D-value is not significant at 05 level. Thus, there exists no significant difference in inquisitiveness aspect of scientific creativity among boys and girls In other words boys and girls are similar on inquisitiveness factor.

Table 7. 9 *Comparison of scores obtained by boys and girls on inquisitiveness aspect of scientific creativity*

C.I.	f_b	f_g	Cum. f_b	Cum. f_g	$S_{69b}(X)$	$S_{69g}(X)$	$\lvert S_{69b}(X)—S_{69g}(X) \rvert$
12—12	2	0	69	69	1.0000	1 0000	0.000
11—13	0	3	67	69	.9710	1.0000	.0290
10—11	4	1	67	66	97!0	.9565	.0145
9—10	5	9	63	65	9130	.9420	.0290
8—9	7	12	58	56	.8406	.8116	.0290
7—8	14	15	51	44	.7391	.6377	.1014
6—7	9	11	37	29	.5362	.4203	.1159
5—6	7	7	28	18	.4058	2609	.1449*
4—5	11	6	21	11	.3043	.1594	.1449
3—4	4	3	10	5	.1449	0725	.0724
2—3	2	1	6	2	.0870	0290	.0580
1—2	4	1	4	1	.0580	0145	.0435

* D—value

Summary and Discussion

This chapter dealt with investigation of sex differences in scientific creativity. Girls have been found to excel boys in overall scientific creativity and in three of the four aspects of it, *viz.* fluency, flexibility and originality Thus, the two sexes differ with respect to scientific creativity but it will not be proper to conclude that these differences are because of sex. These differences may be on account of differences in genotype of boys and girls. Brierley (1967) has pointed out :

> "Exceptionally, a genius is born to unexceptional parents. This is because he has inherited an arrangement of genes which, on the basis of the chance shuffling of chromosome and genes at gamete formation, is extremely improbable. Shakespeare, Goethe, Beethoven, Newton, Ampere, Charlie Chaplin, Dickens, Gauss, Faraday, Kepler, and Einstein appeared out of the blue, although it is likely that their parents were intelligent, The chance

> of another Shakespeare turning up in the same family, for instance in a son, is highly unlikely because when the genius reproduces, his particular gene arrangements are split up. Although they are the same genes that are transmitted to the son, it is even more unlikely that the gene combinations that helped him to become a genius will emerge exactly the same in the child."

Occasionally long family trees of exceptionally gifted people show the perpetuation of gifts as well as the step by step assemblv of an outstanding gene combination culminating in a genius such as Charles Darwin, Francis Galton, John Sebastian, Bach or Titan. But the genius of Erasmus Darwin turned up out of the blue The family tree of the 'Dawin—Wedgwood—Galton Pedigree' shows the inheritance of scientific talent. No doubt, a man's genetic endowment determines his potentialities However, the environment determines the extent to which these potentialities will be fulfilled during development. It is very difficult indeed to disentangle the effects of heredity (nature) and environment (nurture) in a human individual (Brierley, 1967). We agree with the views of Sinnott, et al. (1976) who remarked, "a person, with all his physical, physiological, and mental traits, is necessarily a product of growth and development brought about by a certain genotype in a certain succession of environments. The phenotype of a person at a given moment is determined, of course, not only by the environment that prevails at that particular moment but also by the whole succession of environments he has experiened during his life time. Every person is the product of his genotype and of his life experiences."

To sum up, it becomes clear that the observed differences in scientific creativity among boys and girls may be the products of their genotypes and/or the perceived environment. Lawrenz and Welch (1983) found that students perceived classes taught by females as more formal, more goal directed, more diverse and as having more instances of favouritism and friction between students, and classes taught by males were perceived as more difficult. Studies by Yarrow et al (1971), Margolin and Patterson (1975), Lamb (1976, 1977), Clarke-Stewart (1978), Belsky (1979), Mulhorn and Passman (1981) and Stucky (1982) have indicated existence of sex differences in parent child interaction. So, children's exposure to different amounts of stimulation in their homes and schools may be responsible for sex differences in scientific creativity.

Relationship of Home and School Environments to Scientific Creativity

In the previous chapter an attempt was made to investigate sex differences in scientific creativity It was found that girls excel boys in overall scientific creativity with particular reference to fluency, flexibility and originality. Differences in the genotypes of boys and girls and the environments as perceived by boys and girls might have contributed to the observed variations in the development of scientific creativity. It idicates that scientific creativity among boys and girls may be associated with different aspects of home or school environment as perceived by them The present section embodies our efforts to explore the relationship between perceived school/home environments on the one hand and overall scientific creativity as well as various aspects of it on the other.

8.1. Relationship between Perceived School Environment and Scientific Creativity

Table 8.1 *Tau-coefficients of correlation between school environment and scientific creativity*

Dependent Variable	Value of Tau	Value of Z.	Level of Significance
For boys :			
1. Overall Scientific Creativity	— .1015	1.46	.1442
2. Aspects of Scientific Creativity :			
(a) Fluency	— .0981	1.41	.1586
(b) Flexibility	— .0968	1.39	.1646
(c) Originality	— .1758	2.52	.0152
(d) Inquisitiveness	— .1218	1.75	.0802
For Girls ·			
3. Overall Scientific Creativity :	— .0972	1.45	.1470
4. Aspects of Scientific Creativity			
(a) Fluency	— .0715	1 07	2826
(b) Flexibility	— .0734	1.09	.2758
(c) Originality	— 0984	1.47	.1416
(d) Inquisitiveness	— .1085	1.62	.1052

Table 8 1 shows that school environment as perceived by boys or girls is not significantly correlated with their scientific creativity at .05 level. This indicates that development of scientific creativity among boys and girls is not influenced by their perception of increasing levels of stimulation in school environment Still nothing definite can be said about the promoting or inhibiting role played by school environment in the development of scientific creativity because such non-significant relationships do not exist between the school environment and various aspects of scientific creativity.

In case of boys, originality has been found to be negatively correlated (tau=—.1758) with their perception of stimulation in school environment. This implies that increasing amount of stimulation in school environment may inhibit the development of originality among boys. It also shows that expression of original responses by boys may be accompanied by creation of less congenial climate which does stimulate expression of scientific creativity However, originality in girls does not have a significant relationship with their perception of stimulation in school environment (tau= 0984) This shows the difference in the impact of school environment on development of scientific creativity. It may be the result of increased amounts of motivation and intellectual energy in boys who have greater achievement concerns (Newel, Shaw & Simon, 1962; Wallach & Kogan, 1965).

Three remarkable similarities are apparent in existence of non-significant relationships between three aspects of scientific creativity, *viz.* fluency, flexibility, and inquisitiveness and the stimulation as perceived by boys as well as girls in their school environment. This indicates that less stimulation in school environment may not stifle creativity and more stimulation may not ensure development of scientific creativity in general and fluency, flexibility and inquisitiveness aspects of scientific creativity in particular. We cannot say that less stimulation will not be conducive to more creativity. The reasons for these findings become clear when we think of Hilgard's (1962) views about 'primary process thinking' and 'secondary process thinking' and Weininger's (1977) views. Hilgard's views indicate that scientific creativity may involve less of primary process thinking and more of secondary process thinking. Thus, scientific creativity is less impulse-driven and children with more scientific creativity might have preferred to postpone immediate gratification for future gains and consequently, they might have succeeded in preserving or developing their potential. On the other hand, children with less scientific creativity might have failed in developing their scientific creativity because of their preference for immediate gains and dependence on teachers who reward only conforming behaviours.

Less stimulation, as perceived by boys or girls, might have failed in producing unconscious conflicts that threaten individual's ego and, therefore, children might not have felt the need for protection by repressing all powerful feelings that may be associated with fluency, flexibility, inquisitiveness and scientific creativity. This explanation draws support from Weininger's view that creative potential gets distorted when ego is threatened and the individual starts repressing his feelings.

Thus, except originality all the aspects of scientific creativity possess non-significant relationship with school environment stimulation as perceived by boys or girls. However, we cannot say that the relationship between boys' perception of stimulation in school environment and their scientific creativity is pure This relationship might have been affected by verbal intelligence, nonverbal intelligence, extraversion, neuroticism and socio-economic status. It is, therefore, necessary that the component of variability due to these intervening variables be partialed out.

8.1.1. *Study of Relationship between Boys' Perception of Their School Environment and Their Originality When Intervening Variables Are Held Constant*

Observation of the table 8.2 reveals that when intervening variables are partialed out, the relationship between boys' originality and their school environment has changed from what it was when they were not partialed out. However, the kind and direction of the correlation between originality and perceived school environment (= — 1758) has not changed. The magnitude of this relationship has altered.

Table 8.2 *Kendall partial rank correlation coefficient between boys' originality and their school environment when intervening variables are partialed out*

S.N.	Variable partialed out	Partial Rank Correlation Coefficient
1	Verbal Intelligence	—.1173
2	Nonverbal Intelligence	—.1903
3	Extraversion	—.1746
4	Neuroticism	—.1753
5	Socio-Economic Status	—.1838

When extraversion and neuroticism were partialed out, the resulting correlations (=—.1746 and —.1753) were not much smaller than (.1758). Thus, the relationship between originality and the perceived school environment is relatively independent of the influence of extraversion and neuroticism. The facts that correlations between neuroticism and originality; as well as extraversion and originality are quite low (=.0147 and —.0236) and perceived school environment is not significantly correlated with either extraversion or neuroticism also support the present finding.

When verbal intelligence was partialed out, the obtained correlation between originality and perceived school environment decreased at second decimal place. It indicates that verbal intelligence is tied with school environment so far as development of scientific creativity and originality is concerned. That is, as a determinant of originality school environment operates in different ways at different levels of verbal intelligence.

Correlations between originality and perceived school environment has increased at second decimal point when nonverbal intelligence and socio-economic status were partialed out. Thus, the relationship between school environment as perceived by boys and their originality is, perhaps, tied with nonverbal intelligence and socio-economic status This implies that school environment will operate differently at different levels of nonverbal intelligence and socio-economic status

Above discussion shows how intervening variables influence the role played by school environment in the development of originality Now we will explore how various aspects of creativity in the medium of science *i.e.* scientific creativity, are related to different aspects of school environment.

8.1 2. *Relationship between Various Aspects of School Environment and Scientific Creativity*

Table 8 3 shows values of Spearman rank correlation coefficients between children's perception of various aspects of school environment and their fluency, flexibility, originality, inquisitiveness and overall scientific creativity. Perusal of correlations given in column two of this table shows that in case of girls no significant correlation has been found between fluency, flexibility, originality inquisitiveness and scientific creativity on one hand and creative stimulation aspect of school environment on the other. This indicates that neither more nor less creative stimulation in the school if it is perceived so by girls, may influence the development of scientific creativity in general and fluency, flexibility, originality and inquisitiveness aspects of scientific creativity in particular.

Table 8.3 *Relationship between various aspects of school environment and scientific creativity*

Dependent Variable	Values of Spearman rank correlations for various aspects of school environment					
	CRS	COE	PER	ACC	CON	REJ
1	2	3	4	5	6	7
1. Overall Scientific Creativity	— .1996	— .2554*	— .1970	— .1539	— .0514	.1040
	1412	**— .0255**	**.0401**	**0382**	**.1049**	**— 0593**
2. Aspects of Scientific Creativity.						
(i) Fluency	— .1359	— 0196	— .1566	— 1299	— 0525	1161
	0711	**— .0454**	**.0158**	**0437**	**1051**	**— 0726**
(ii) Flexibility	— 2214*	— 1867	— .1425	— .2043*	— 0573	1234
	1189	**— 0504**	**0264**	**0047**	**0255**	**— 0456**
(iii) Originality	— 2147*	— .2681**	— 2056*	— 1633	— 0418	.1323
	1102	**— 0212**	**0476**	**0544**	**.1098**	**— 0211**
(iv) Inquisitiveness	— 1846	— 2699**	— .1813	— .1131	— .0449	0302
	0888	**— 0692**	**1103**	**— 0358**	**0467**	**.0552**

*/** Significant at 05/ 01 level

Responses to items on CON and REJ aspects of school environment have been negatively scored.

Values of rank correlations for girls appear in bold face type Other values are for boys.

Aspects of school environment CRS=Creative Stimulation ; COE=Cognitive Encouragement ; PER=Permissiveness ; ACC=Acceptance ; CON=Control ; REJ=Rejection.

The relationship between boys' perception of creative stimulation in school environment and their fluency, inquisitiveness, and scientific creativity is not significant at 05 level This means that the degree of creative stimulation which is perceived by boys in their school environment has nothing to do with the development of scientific creativity. All these findings are quite striking. Author, like Wallach and Kogan (1965), thinks that highly creative girls may be more bored by various classroom routines than their less creative peers Hence, the former might engage in attention-seeking behaviours in the service of a need for variety. They might have displayed little hesitation in expressing their opinions. Thus, more boredom resulting from excessive stimulation might have intervened and checked stimulating effect of creative stimulation on the development of scientific creativity. The same arguments may hold truth in case of boys. However, flexibility and originality aspects of scientific creativity have been found to be significantly related with boys' perception of increasing levels of creative stimulation in school environment. The obtained rank correlation coefficients were negative and significant at 05 level This implies that perception of increased quantitites of creative stimulation may inhibit the development of flexibility and originality among boys This finding draws support from Heck's (1978) views He thinks, "A creative environment does not necessarily teach a child what to think but rather assists him in how to think A stimulating environment provides the motivation for a child to become a miniature researcher through the process of reading, living, and recalling."

Thus, it becomes evident that excessive emphasis on stimulating environment with least stress on the knowledge that is to be used during creative expression may be inimical for the development of scientific creativity. This may be a potent factor that might have led to low flexibility and originality among boys who perceived more creative stimulation. It may be because of the comparatively more help being given to young children to explore their environment and their feelings and find ways to handle their emotions and their relationships with others in the school environment. Fulfilment of their basic needs of belongingness and

security might have been met while boys were planning and acting out in the creative environment. They might be aware of how to motivate and discipline themselves and their emotions (Tyas, 1971) and this fact may be responsible for the development of more flexibility and originality among boys who perceived low level stimulation for creative work in their schools Plowman's (1978) views also support the implication that more perceived creative stimulation in school environment may inhibit the development of flexibility and originality He has stressed the role of integrative learning in the development of creativity. If we were to seriously analyse the teaching-learning-activities that exist in most of the science classes, we might conclude that our individual learning plans are not holistic but fragmented in nature, i.e in one learning experience children are usually involved in acquisition of basic, advanced or isoteric knowledge, but during the same learning activities they are never exposed to ideas which engender creative expression or production in science. Attempts to promote acquisition of problem-defining and problem-solving skills as well as traits like adaptive flexibility, ideational fluency and originality are seriously lacking in our activities in science classes. In this lack of integrative learning, the presence of a socio-emotional climate designed to encourage scientific creativity in particular and creativity in general might have been least potent in promoting the development of scientific creativity.

Column 3 of table 8.3 shows Spearman rank coefficients of correlation between children's perception of increasing quantities of cognitive encouragement in school environment and their scientific creativity. Observation of this column reveals that all aspects of scientific creativity, when considered separately or in toto, exhibit no significant relationship with cognitive encouragement in respect of girls. It indicates that development of scientific creativity among girls may not be influenced by their perception of more or less cognitive encouragement that exists in their school environment

Rank coefficients of correlation between boys' perception of cognitive encouragement in their school environment and their scientific creativity

reveal an interesting phenomenon. In their case fluency and flexibility have been found to be insignificantly correlated with boys' perception of cognitive encouragement in school environment. However, the correlations between originality, inquisitiveness and scientific creativity and cognitive encouragement are significant at .01, .01, and .05 levels respectively, meaning thereby, that increased cognitive encouragement may lead to inhibition of originality, inquisitiveness and scientific creativity while decreased level i e. less cognitive encouragement may contribute to the development of scientific creativity in general and originality and inquisitiveness in particular. Occurrence of these negative and significant relationships is a startling one because information is the stuff out of which productive ideas are made. The possession of functional scientific information which is the transferable information, is important for the development of scientific creativity. The obtained relationships may be the reflections of the excessive emphasis laid by students and teachers on acquisition of knowledge that is strongly chained to the cues and contexts with which it was learned. Such a pool of information cannot be expected to be free to emerge in new connections and new contexts. Guilford's (1977) 'information theory of creative thinking' also supports this hunch. Besides this, individual attitudes and intellectual skills that apply at the time of retrieval (skills in the form of SI abilities) may have a significant impact on creative expression of students in the field of science. If we were to seriously think about the cognitive and methodological aspects of science education, as it is being imparted in many schools, this fact becomes more evident Our teachers usually encourage cognitive development among boys. They do not teach for deep conceptualizations and for logical interrelationships and organizations and these may account for the obtained negative but significant relationship. The inference that perception of cognitive encouragement in school environment influence the growth of scientific creativity is an interesting one This draws support from views of Wallach and Kogan (1965) on 'distinctive sets of role behaviours'. According to them, the heavily sex-typed behaviours can serve as guiding models. They stress achievement centred behaviours more strongly in males than females.

Observation of column 4 of the table 8 3 reveals that the rank coefficients of correlation between boys' perception of permissiveness in school. environment and their flexibility, inquisitiveness and scientific creativity and girls' perception of permissiveness in school environment and their fluency, flexibility, originality, inquisitiveness and scientific creativity are not significant at 05 level. This means that neither more nor less permissiveness has a significant impact on the development of fluency, flexibility, inquisitiveness

and scientific creativity among boys and fluency, flexibility, originality, inquisitiveness and scientific creativity among girls

Besides these correlations, the correlation between boys' originality and their perception of permissiveness in school environment i.e negative and significant at .05 level. This implies that expression of original behaviours may be followed by restrictions on pupils' behaviour i e less permissiveness. This also indicates that less permissiveness may be conducive to the development of scientific creativity The availability of less stimulation as a result of perception of less permissiveness by boys might have produced greater anxiety in the scientifically creative boys and this anxiety might have motivated the creative ones to become adept in both reflection and deliberate introspection as well as free-wheeling impulsivity. Biography of Priestley, Darwin, Kepler and several leading physicists provide innumerable evidences of a high anxiety level in them (Cattell 1963) This adaptation might be responsible for the development of their originality. Their positive attitudes toward development of their valuable asset, *i e* scientific creativity, especially originality, together with their skill in modelling abilities important for creative thinking in science might be responsible for development of boys' originality when less permissiveness was perceived to exist in school environment Belcher (1975) and Frederickson & Evans (1971) have considered these two factors to be most important for creative thinking.

Observation of column 5 of table 8.3 reveals that the correlations between perceived acceptance in school environment and boys' fluency, originality, inquisitiveness and scientific creativity ; and girls' fluency, flexibility, originality, inquisitiveness and scientific creativity are not significant at .05 level. This reflects that children's perception of acceptance in their school environment does not play any important role in the development of scientific creativity among boys as well as girls in general and fluency, originality and inquisitiveness among both boys and girls and flexibility among girls in particular It also indicates that acceptance in school environment may not be associated with scientific creativity among children. That is children's expression of more or less creative behaviour will not influence teacher pupil-interactions so far as acceptance of their rights as individuals are concerned This may be the typical finding in the Indian context. Teachers have to play an important role in the development of children's personality and cognition and these roles demand that children's individuality must be accepted So, our teachers might not have discriminated the highly creative and the low

creative science students from the normal ones and therefore, these students might not have experienced different amounts of acceptance because of the differences in amounts of their scientific creativity.

Besides the nine non-significant correlations one correlation (—.2043) between perceived acceptance and flexibility among boys is significant at .05 level This indicates that more acceptance, if perceived as more acceptance by boys, may inhibit the growth of flexibility in boys' behaviour relevant to science It also implies that boys' flexibility will develop if they experience less acceptance in teacher-pupil-relationships. This may be the outcome of the fact that usually boys' behaviour to deviate from the norm is not accepted by teachers in ordinary situations When teahers' behaviour showed low level of acceptance, the highly creative boys who do not believe in acting out more attention-seeking behaviours (Wallach & Kogan, 1965), might have developed anxiety for preserving their uniqueness and, because of their highly dominant nature, greater creative motivation, more intellectual energy and excessive persistence they might have succeeded in developing their flexibility to some extent.

Examination of the rank coefficients presented in column 6 of table 8.3 reveals that there does not exist any significant relationship between the amount of control as perceived by boys or girls and their scientific creativity in general and their fluency, flexibility, originality and inquisitiveness in particular. This means children's perception of decreasing quantity of control in school environment has no significant impact on the promotion or inhibition of the development of scientific creativity. This may be the reflection of strict discipline imposed by teachers on all the students who with the passage of time learn to exercise self-control on their activities. They might have learnt when and how to express their scientifically creative behaviour in the class or outside the class. When we consider the views of Barron and Bruner, it becomes evident that the scientifically creative children might have enjoyed situations presenting opportunities for challenge and innovation, preferred opinions arrived at by themselves, or—they could not have developed emotional tensions because of more control Their striving self-confidence and commitment might have contributed to development of their scientific creativity in complex environments.

Column 7 of table 8 3 shows that correlations between children's perception of rejection in school environment and their fluency, flexibility, originality, inquisitiveness and scientific creativity are not significant

statistically. This indicates that decreasing quantity of rejection in school environment, if perceived so by children, may not contribute to development of scientific creativity among boys and girls It is quite disturbing to say that children's scientific creativity may not be adversely affected when teachers do not accord recognition to student's right to deviate, act freely and be an autonomous person. It seems that children are not much sensitive to rejection as exercised by their teachers It is apparent that use of least rejection for a child may not guarantee the development of his creative potential unless his or her genetic endowments and intellectual abilities influence this development positively It may be the reflection of inconsistency in teachers' behaviour to use rejection as a device for shaping child's particular behaviour exhibited on different occasions. Effect of more rejection on development of scientific creativity would not have occurred because it might have failed to cause development of emotional tensions which block creative behaviour of children. This discussion indicates that an exhaustive programme designed for the development of scientific creativity need not lay much emphasis on avoidance of rejection

Summary

Till now we tried to study relationship between perceived school environment and scientific creativity Our efforts have revealed existence of no significant relationship between perceived school environment and overall scientific creativity among boys as well as girls. In the case of boys originality aspect of scientific creativity was found to be negatively correlated with perceived school environment This relationship has been found to be tied with verbal intelligence, nonverbal intelligence and socio-economic status However, it was relatively independent of the influence of extraversion and neuroticism

When the relationships between various aspects of school environment on the one hand and overall scientific creativity and various aspects of it on the other were studied, girls' overall scientific creativity and various aspects of it were found to be insignificantly related with all the aspects of perceived school environment. In case of boys, our findings indicated that increasing levels of creative stimulation may lead to the development of low flexibility and originality, while increasing levels of cognitive encouragement were found to be negatively associated with overall scientific creativity and originality and inquisitiveness aspects of it. Acceptance and permissiveness (increasing levels) were found to be negatively associated with flexibility and originality aspects of scientific creativity. Besides these, other relationships were not significant at .05 level.

8 2. Relationship between Perceived Home Environment and Scientific Creativity

Discussion in the preceding pages indicates that school environment influences the growth of scientific creativity among boys. Girls appeared to be immune to the effects of school environment. However, Smith and Geoffry (1968) suggested that the process of schooling is not isolated from parental influences Review of researches by Watts (1970) shows that cognitive development is highly dependent upon the verbal and effective interaction between the parent and the child This phenomenon requires further probe into the relationship between scientific creativity among boys and girls and the perceived home environments

Table 8.4 *Tau coefficients of correlation between home environment and scientific creativity*

Dependent variable	Value of Tau	Z Value	Level of Significance
For boys			
1 Overall Scientific Creativity	1015	1 46	1442
2 Aspects of Scientific Creativity			
(a) Fluency	0868	1 25	2112
(b) Flexibility	0762	1 10	2714
(c) Originality	1102	1 58	.1142
(d) Inquisitiveness	1941	2.78	0054
For Girls			
3 Overall Scientific Creativity	1741	2 59	.0096
4 Aspects of Scientific Creativity			
(a) Fluency	.1502	2 24	0250
(b) Flexibility	1306	1 95	0512
(c) Originality	2267	3 38	0007
(d) Inquisitiveness	0611	0 91	8336

Table 8. 4 shows that tau-coefficients of correlation between perceived home environment and inquisitiveness among boys , and fluency, originality and scientific creativity among girls are significant at .005, .025. .0007 and .0096 levels respectively The remaining correlations are not significant at .05 level.

The coefficient of correlation between perceived home environment and boys' inquisitiveness is low (= 1941) and positive. It shows that perception of more stimulation in home environment may lead to the development of inquisitiveness. It also indicates that parents stimulate children's ability to ask questions i e. their inquisitiveness We cannot conclude that perception of more stimulation in home environment will be conducive to the development of fluency, flexibility and originality in particular and scientific creativity in general. This is evident because only one aspect of scientific creativity among boys is positively and significantly correlated with perceived home environment

Observation of the table 8 4 reveals that perceived home environment is positively correlated with fluency, flexibility, originality, inquisitiveness and scientific creativity among girls. The tau-coefficients are 1502, 1306, .2267, .0611 and 1741 respectively. Out of these five coefficients of correlation, two are not significant at .05 level while the remaining three coefficients are significant. This shows that perception of more or less stimulation in home environment may not affect the growth of flexibility and inquisitiveness among girls However, its effects will be pronounced in case of fluency, originality and scientific creativity That is, perception of more stimulation may contribute to the development of scientific creativity in general and fluency and originality in particular.

Analysis of above discussion shows that perception of more stimulation in home environment can be of paramount importance in the development of inquisitiveness among boys , and fluency, originality and scientific creativity among girls This indicates that home environment operates differently in case of boys and girls to influence the development of their scientific creativity These findings may be the reflections of environmental consistency for females and inconsistency in parental child—rearing behaviours in case of girls i e boys might have failed to guess their parent's behaviour. This phenomenon can be readily observed in most of the families in Uttar Pradesh. Evans and McCandless (1978) have aptly remarked, "Most of us who have children or who have worked with children have observed them react differently to uniform treatment." This stresses

the possibility that as compared to boys girls would have been more sensitive to the stimulation available in the home environment and might have reacted sharply to less stimulation. Existence of more scientific creativity among girls also supports the present implication

On comparing the correlations between children's scientific creativity (overall and various aspects of it) and school environment with the correlations between scientific creativity (overall and various aspects of it) among children and home environment, we find that perception of more stimulation in school environment may contribute to the development of originality aspect of scientific creativity among boys while the perception of more stimulation in home environment may contribute to development of inquisitiveness among boys , and overall scientific creativity and fluency, originality and inquisitiveness aspect of it among girls Thus, it becomes evident that stimulation in school environment may play a prominent role in the development of scientific creativity, specially originality aspect of it among boys but girls' scientific creativity may be influenced by their perception of stimulation in home environment This reflects idiosyncratic effects of home and school environments on the development of scientific creativity among boys and girls. Boys' scientific creativity may be adversely affected by their perception of more stimulation in school environment. Scientific creativity among girls is not significantly affected by their(girls') perception of stimulation in school environment The reasons for this difference may be hunched in differences among boys and girls with respect to their attitudes towards the school, their teachers, their potentialities and their sensitivity and ego strength Author's experiences indicate that whenever school presents a very stimulating climate for students, students become careless and they do not work and study sincerely. This phenomenon may be observed in some of our schools where only the more stimulating psycho-social climates exist (*i e* where cognitive programmes for the development of scientific creativity or students' reasoning abilities do not exist). Boys usually become inactive or indifferent to school programmes in such schools. So, it seems that boys' scientific creativity may be adversely affected by their schools simply because boys may not utilize the opportunity for developing their scientific creativity. It is interesting to note that boys' perception of more stimulation in home environment may be conducive to the development of their inquisitiveness, an aspect of scientific creativity. These comparisons also indicate that as compared to boys girls may be more sensitive to stimulation in their homes. This is a hunch to be verified through further investigation

The relationship between boys' inquisitiveness fluency

the other is not pure. Verbal and nonverbal intelligence, neuroticism, extraversion and socio-economic status might have affected this relationship. It is therefore necessary that the component of variability due to verbal and nonverbal intelligence, neuroticism, extraversion and socio-economic status be partialed out leaving the correlations between perceived home environment and the dependent variables (inquisitiveness among boys ; and fluency, originality and scientific creativity among girls) unaffected by variability in intelligence (verbal as well as nonverbal), neuroticism, extraversion and socio-economic status The residual correlations may be considered to be indicative of true relationship that might be existing between different sets of variables

Let us now explore the relationship between children's perception of their home environment and scientific creativity variables when intervening variables are held constant

8. 2. 1 *Relationship between Boys' Perception of Their Home Environment and Their Inquisitiveness When Intervening Variables Are Held Constant*

Table 8.5 *Kendall partial rank correlation coefficient between boys' perception of home environment and their inquisitiveness when intervening variables are partialed out*

S N	Variable partialed out	Partial Rank Correlation Coefficient
1	Verbal Intelligence	.1206
2.	Nonverbal Intelligence	1433
3	Neuroticism	.2121
4	Extraversion	.1838
5.	Socio-Economic Status	.1364

Observation of table 8 5 reveals that when intervening variables are partialed out, the relationship between home environment as perceived by boys and their inquisitiveness (tau= 1941) has altered However, partialing out of verbal as well as nonverbal intelligence, neuroticism, extraversion and socio-economic status has not affected the kind and direction of the correlation It has affected its magnitude

When extraversion was partialed out, the resulting partial correlation (= 1838) was not much lower than .1941 Thus, the relationship between perceived home environment and inquisitiveness among boys is relatively independent of the influence of extraversion It implies that home environment does not operate differently at different levels of extraversion.

When effects of verbal intelligence, nonverbal intelligence and socio-economic status were partialed out, the value of the coefficient of correlation decreased at second decimal place Another interesting finding is increase in the coefficient of correlation when neuroticism was not allowed to vary This shows that the true relationship of perceived home environment and boys' inquisitiveness is perhaps tied with the level of verbal and nonverbal intelligence, neuroticism and socio-economic status It indicates that home environment, as a determinant of scientific creativity, may operate differently at different levels of intelligence (verbal and nonverbal) neuroticism and socio-economic status.

8 2. 2 *Relationship between Girls' Perception of Their Home Environment and Their Fluency When Intervening Variables Are Held Constant*

Table 8. 6 *Kendall partial rank correlation coefficients between girls' perception of home environment and their fluency when intervening variables are partialed out*

S.N	Variable partialed out	Partial Rank Correlation Coefficient
1	Verbal Intelligence	.1180
2.	Nonverbal Intelligence	.0982
3.	Neuroticism	.1434
4	Extraversion	.1511
5	Socio-Economic Status	.1181

Table 8.6 reveals altered relationship between perceived home environment and girls' fluency when intervening variables have not been allowed to vary. When effects of intervening variables were not partialed out, the coefficient of correlation between the two variables was .1502. After partialing out the effect of verbal intelligence, nonverbal intelligence, neuroticism and socio-economic status, comparatively low correlations were obtained. Out of these four low partial rank correlations, one correlation which has been obtained after partialing out neuroticism is not much smaller than .1502 Other correlations exhibit decrease at second decimal place. These findings show that the true relationship of perceived home environment and girls' fluency is tied with verbal and non verbal intelligence and socio-economic status It means that effects of home environment on the development of fluency among girls will be different for those who are different with respect to intelligence (verbal as well as nonverbal) and socio-economic status

The correlation obtained after partialing out neuroticism shows that home environment does not operate differently at different levels of neuroticism. This implication does not hold truth in case of extraversion. When extraversion was partialed out, the resulting coefficient of correlation was increased at fourth decimal place. This implies that home environment effects the development of fluency in different ways at different levels of extraversion

8. 2. 3. *Relationship between Girls' Perception of Their Home Environment and Their Originality When Intervening Variables Are Held Constant*

Table 8. 7 *Kendall partial rank correlation coefficients between girls' perception of home environment and their originality when intervening variables are partialed out*

S.N.	Variable partialed out	Partial Rank Correlation Coefficient
1	Verbal Intelligence	1947
2.	Nonverbal Intelligence	1712
3	Neuroticism	.2259
4	Extraversion	.2292
5.	Socio-Economic Status	.1912

Table 8.7 shows that when extraversion is partialed out, the obtained value of coefficient of correlation between girls' perception of home environment and their originality (tau=.2263) shows increase in its magnitude at the third decimal place. This increase in the coefficient of correlation indicates that extraversion influences the relationship between perceived home environment and originality It means that the influence produced by home environment on the development of girls' originality in the field of science is different for girls who differ with respect to extraversion. That is, at different levels of extraversion home environment operates differently to affect development of originality

When verbal and nonverbal intelligence and socio-economic status are partialed out, the correlation decreases at second decimal place Thus, the true relationship between perceived home environment and girls' originality is, tied with the level of verbal and nonverbal intelligence and socio-economic status It implies that home environment, as a determinant of originality among girls, may operate in different ways at different levels of verbal and nonverbal intelligence and socio-economic status

When neuroticism was not allowed to vary, the correlation between home environment as perceived by girls and their originality exhibited negligible decrease at the fourth decimal place This indicates that relationship is not tied with the level of neuroticism In other words, as a determinant of originality in the field of science home environment will not act in different ways at different levels of neuroticism

8 2.4 *Relationship between Girls' Perception of Their Home Environment and Scientific Creativity When Intervening Variables are Held Constant*

Table 8.8 *Kendall partial rank correlation coefficients between girls' perception of home environment and their scientific creativity when intervening variables are partialed out*

S N	Variable partialed out	Partial Rank Correlation Coefficient
1	Verbal Intelligence	.1389
2.	Nonverbal Intelligence	1145
3.	Neuroticism	1706
4.	Extraversion	1751
5.	Socio-economic status	.1356

Table 8.8 reveals that when intervening variables are partialed out, the relationship between home environment as perceived by girls and scientific creativity (tau= 1741) among girls changes in its magnitude only while the kind and the direction of the correlation remain unaffected

When neuroticism was partialed out, the resulting correlation (= 1706) was not much smaller than 1741 Thus, the relationship between perceived home environment and scientific creativity as measured by the tools used in this study, is relatively independent of the influence of neuroticism. This indicates that the effect produced by home environment on the originality among girls will not be altered i e. intensified or reduced by neuroticism in girls' behaviour

When verbal intelligence, nonverbal intelligence and socio-economic status were separately partialed out, the correlations obtained between perceived home environment and scientific creativity decreased at the second decimal place It indicates that verbal intelligence, nonverbal intelligence and socio-economic status are tied with home environment and stand in the way of high level scientific creativity That is, home environment may operate in different ways at different levels of verbal and nonverbal intelligence and socio-economic status

One interesting thing has emerged out of this analysis. After partialing out the effect of extraversion, the value of coefficient of correlation has increased Previously when extraversion was allowed to vary, the obtained coefficient of correlation was .1741 The increase is at the third decimal place. Thus, the true relationship of home environment as perceived by girls with their scientific creativity may be tied with the level of extraversion It implies that girls differing with respect to extraversion may be subjected to different effects of home environment so far as development of scientific creativity is concerned

8.2.5 *Relationship between Various Aspects of Home Environment and Scientific Creativity*

The values of Spearman rank coefficients of correlation between various aspetcts of home environment and scientific creativity have been shown in table 8.9

Table 8 9 *Relationship between various aspects of home environment and scientific creativity*

Dependent Variable	CON	PRO	PUN	REW	COY	SOI	DEP	REJ	NUR	PER
	Values of Spearman rank correlations for various aspects of home environment									
1	2	3	4	5	6	7	8	9	10	11
1 Overall Scientific Creativity	0200	—.0926	0988	— 0049	— 1522	1738	1706	1578	0820	2503*
	— 1089	**— 0115**	**0979**	**0977**	**0505**	**0879**	**0301**	**1921**	**2225***	**.0746**
2 Aspects of Scientific Creativity	0014	— 1214	1168	— 0046	— 1225	1398	1725	1500	.0925	1881
(i) Fluency	**0874**	**0606**	**.0899**	**0459**	**.0602**	**0793**	**0697**	**2059***	**2110***	**1073**
(ii) Flexibility	—.0488	—.1533	.0683	.0007	— 1250	1673	1546	1569	0692	1969
	0594	**0275**	**0862**	**0800**	**.0790**	**0170**	**0596**	**1940**	**2040***	**— 0210**
(iii) Originality	0887	—.3040	1082	— 0257	— 1429	1827	2139*	1645	.0363	.2351*
	1646	**— 0066**	**.1066**	**1438**	**0594**	**0767**	**0505**	**1537**	**2180***	**1023**
(iv) Inquisitiveness	—.0344	— 2030*	— 0286	1206	— 2865**	.1507	1251	1354	2693**	2757**
	— 0049	**2026***	**— 1527**	**.0333**	**0983**	**— 0063**	**.0609**	**2885****	**1322**	**— 0970**

*/** Significant at 05/ 01 level

Correlations in bold face type are those for girls and others are for boys

All aspects of home environment except those mentioned in Columns 5, 10 and 11 have been negatively scored

Aspects of home environment CON : Control , PRO . Protectiveness , PUN : Punishment , REW . Reward , COY : Conformity , SOI Social Isolation ; DEP Deprivation of Privileges , REJ Rejection ; NUR Nurturance ; PER . Permissiveness

Observation of column 2 of table 8.9 reveals that the Spearman rank correlations between perception of (decreasing quantity) control in home environment and fluency, flexibility, originality, inquisitiveness and scientific creativity among boys as well as girls are not significant at 05 level. Hence we cannot say whether less control, as perceived by children, will be conducive to scientific creativity or more control, if perceived so by children, will inhibit or retard the development of scientific creativity Thus, use of strict control by parents i e imposition of many restrictions on children to discipline them, may neither promote nor inhibit the development of scientific creativity among boys and girls. Fuqua, Bartsh and Phye (1975) report that creative performance calls for deliberate and systematic analysis in the early stages of a problem or task situation It becomes clear that strict control, if exercised by parents to discipline disorganized or undesirable activities, may not hinder the growth of creativity in science This explanation does imply that less control may not promote the growth of scientific creativity However, our findings do not support such an inference. Some parents may be more liberal and tolerant in their general outlook Gatzels and Jackson (1962) have reported these characteristics among parents of highly creative children. It may be that because of their higher intellectual energy and strong motivation to pursue their activities that highly creative children succeed in developing their scientific creativity by exercising self control on their behaviour In our daily life situations we do find that less creative children do not have the stronger motivation to pursue their creative work in science They fail to exercise self-control on their activities Thus, perception of less control in home environment may not set the stage for the development of their creativity in science. At the same time more control may not allow them to express creatively because they are more conforming and will act according to the restrictions imposed on them Such discussions draw support from the fact that evidence is far from consistent on whether creativity is more likely to flourish in stress-free situations (Channon, 1974 , Milgram and Milgram, 1976) Analysis of studies done by Roe, Gallagher, Aldous, Heilbrin, Ellinger, Straus & Straus, Terman, Weisberg & Springer, and Nuttal has not enabled us to decide the role played by control in the development of creativity. Torrance's views also lend support to our findings His views indicate that when groups develop a varied repertoire for controlling their most creative members, the most creative individuals develop a varied repertoire of techniques of adaptation According to him these adaptation techniques of the most creative members include compliance, counteraggressiveness, indomitable persistence, apparent ignoring of criticism, clowning, silence and apathy or preoccupation, inconsistent performance, filling the gaps when others

falter, solitary activity and the like. Thus, even when exposed to strict family control, the creative children might succeed in developing their scientific creativity Similar results have been reported in case of control in school environment as perceived by boys and girls.

Column 3 of table 8 9 shows that the correlations between children's (boys as well as girls) perception of decreasing levels of protectiveness in home environment and their fluency, flexibility, originality and scientific creativity are not significant at .05 level This indicates that neither less nor more protectiveness is likely to influence the development of fluency, flexibility and originality in particular and scientific creativity in general. This may be the reflection of parental behaviours concerned with prevention of children's independent behaviour and prolongation of infantile care These behaviours might have been the same for all children irrespective of differences in their scientific creativity

It is interesting to note that boys' perception of protectiveness (decreasing quantities) is negatively correlated with inquisitiveness (— 2030) while in case of girls the relationship between the two variables is positive (.2026). Both values of coefficients of correlation are significant at 05 level meaning thereby, that more protectiveness will be associated with more inquisitiveness in case of boys and less inquisitiveness in case of girls. This implies that prevention of independent behaviour and prolongation of infantile care may lead to the development of more inquisitiveness among boys and this may inhibit or retard the development of inquisitiveness among girls. Thus, it appears that boys and girls might react differently to perceived amounts of protectiveness Aldous (1975) has found overprotectiveness to be associated with less original behaviour. This finding contradicts our finding of existence of no significant relationship between girls' originality and protectiveness However, Roe's (1960) conclusion that overprotectiveness of parents may favour the growth of creativity among children supports our conclusion that overprotectiveness may be conducive to the growth of inquisitiveness among boys Research findings are not conclusive on this point.

Column 4 of table 8 9 reveals that none of the ten correlations is significant at 05 level It indicates that fluency, flexibility, originality, inquisitiveness and scientific creativity among boys as well as girls is not much related with their perception of decreasing levels of punishment in home environment This implies that use of physical as well as affective punishment by parents to avoid the occurrence of undesirable behaviour among

children may not affect the growth of scientific creativity in them This finding goes against the results of a study done by Mari (1971).

The reasons that explain development of scientific creativity among children experiencing more punishment may be

(1) The highly creative children might have failed to predict the behaviours which lead to use of punishment by parents. This may be because of inconsistencies in parent's childrearing behaviour

(2) Inspite of less stimulation resulting from more punishment, emotional tensions that may block expression of scientifically creative behaviour would have ceased to develop.

(3) Children might have faced key choice points involving sexuality, vocational planning, more advanced moral development and emancipation from parents Havighurst (1972) regards these problems as developmental tasks and their successful achievement might have led to positive adjustment and success with later tasks.

(4) Sometimes after use of punishment, parents might have spent considerable time discussing with their children why they misbehaved, how the behaviour was inappropriate, how such behaviour can cause problems for the child with others outside the family, and how to achieve the desired goals These discussions might have led to the development of insights in human relationships and behavioural inconsistency, as revealed in parental childrearing behaviours, might have tought them when and how to express their scientific creativity.

(5) Children's knowledge of their valuable potentiality, their greater intellectual energy and motivation to pursue their creative science activities their acceptance of parental controlling behaviour (i e punishment) as an attempt to distort their individuality or stifle their potentiality might have made them immune to punishment. Thus, punishment would have been ineffective in controlling expression of creative behaviours.

Examination of column 5 of table 8 9 reveals that correlations between perceived amounts of reward in home environment and fluency, flexibility, originality, inquisitiveness and scientific creativity among boys and girls are not significant at .05 level This implies that more or less rewards to strengthen or increase the probability of desired behaviour may or may not contribute to the development of various aspects of scientific creativity.

It may be the reflection of the fact that highly creative students believe that rewards are contingent upon one's efforts and are not governed by chance, luck, fate or systems (Aggarwal & Verma, 1977). They might have been satisfied with their creativity and have decided to think and work creatively with no desire for extrinsic rewards for such behaviours Amabile (1982) proposed that intrinsic motivation is conducive to creativity while extrinsic motivation is detrimental This was not supported by findings of the study which revealed the superiority of girls who expected that prizes would be raffled off to girls who competed for prizes on artistic creativity. Thus, both more and less rewards may be conducive to the growth of scientific creativity Rewarding and rich set of experiences during infancy and the preschool years might have enabled them to move along well through the present stage in cognitive development (Piaget, 1970).

Observation of column 6 of table 8 9 reveals that correlations between conformity (decreasing levels) in home environment and fluency, flexibility, originality and scientific creativity among boys as well as girls are not significant at .05 level It means that decrease in conformity in home environment, if perceived so by children, may neither promote nor hinder the development of fluency, flexibility, originality and scientific creativity among children The present finding acts like a bridge between two types of findings, *viz.* those pointing out that more parental conformity favours creativity (MacKinnon, 1965; Aldous, 1975) and those reporting inhibition-effects of more conformity (Dryer & Wells, 1966 ; Mari, 1973 ; Stein, 1963) Stoddard's (1959) contention that "conformity rules, not because people crave it but because they fear deviation" is quite relevant in connection with our findings Hence, it may be the quality of boldness to deviate from the prescribed norm that might be responsible for the growth of scientific creativity among children possessing higher scientific creativity. At the same time fear of consequences owing to deviation from the norms might have caused inhibition of scientific creativity among low scientifically creative children.

Kneller (1963) has pointed out that the creative person is flamboyant and unconventional in his style of life and these traits of social unconventionality are sometimes mistaken for necessary conditions of creativity rather than concomitants for it. Studies of creative mathematicians, scientists, writers, architects and business managers, as summarized by Barron (1969), show that in addition to being flexible, curious, and original, they are individualistic, nonconforming, unsociable, low in impulse-control, independent and willing to take risks These personality traits might have enabled the highly creative children to preserve and to develop their scientific creativity.

This table also reveals an interesting situation The correlation between perceived conformity and inquisitiveness is negative but significant in case of boys (—.2865) and non-significant (—.0983) in case of girls. This means that decreased amount i.e. less conformity in home environment, as perceived by boys may lead to the development of less inquisitiveness and increase in the degree to which parents demand work according to their desires and expectations may be associated with development of more inquisitiveness among boys. However, it may not influence the development of inquisitiveness among girls. As stated by Pine (1959), the scientifically creative girls might have expressed their drives in relatively untransformed forms and their individual drive content would not have much modified in accordance with social dictates and their impulse might have been expressed in somewhat tolerable socially acceptable form. Thus, their scientific creativity would have remained free from the detrimental effects of parental conformity. Cropley's conceptualization of 'creativity as a social phenomenon' may be more relevant in case of boys He thinks that creative persons have a disposition to behave in what are essentially poorly socialized ways Despite their obvious and real utility socialization processes have anticreative side effects in that extremely clearcut, strongly preserved and observed societal norms militate against the appearance of widely divergent behaviours in a culture and hence against creativity This conceptualization may be true in case of scientific creativity too In view of this our finding is quite startling However, it may be the reflection of the effect produced by lack of extremely clearcut and strongly observed family norms or conventions and of the less stress placed by parents on forcing the development of extremely socialized individuals.

Column 7 of table 8.9 shows that correlations between children's (boys' and girls') perception of social isolation in home environment and their fluency, flexibility, originality, inquisitiveness and scientific creativity is not significant at .05 level This means perception of more social isolation i e use of isolation from beloved persons except family members for negative sanctions, is not associated with more or less scientific creativity among boys and girls. It also indicates that use of less social isolation by parents may not contribute to the development of scientific creativity.

Observation of column 8 of table 8 9 reveals that girls' perception of deprivation of privileges in home environment is not significantly correlated with their fluency, flexibility, originality, inquisitiveness and scientific creativity This indicates that parental behaviours for controlling children's behaviour by depriving them of their right to seek love, respect and child-care from parents may neither promote nor inhibit the development of scientific

creativity in general and its four aspects, *viz.* fluency, flexibility, originality and inquisitiveness in particular. The correlations between boys' perception of deprivation of privileges as used by parents and their fluency, flexibility, inquisitiveness and scientific creativity are not significant at .05 level. This implies whatever be the amount of deprivation of privileges boys' fluency, flexibility, inquisitiveness and scientific creativity will not suffer or develop by leaps and bounds These may be the results of individual differences in how children react to such parental behaviours. Does the same behaviour of a child when expressed at different occasions leads to the same parental controlling behaviour *i.e.* behavioural consistency ? This may be the effect of strong drive toward verbal expression, greater confidence and intellectual energy, desire to postpone immediate gratification of impulses for future gains, positive attitude towards scientific creativity and independence in judgement and behaviour that has enabled the creative students to preserve and develop their scientific creativity.

The correlation between deprivation of privileges (decreasing) and originality among boys is positive (=.2139) and significant at 05 level. This means that originality is more likely to be influenced by differences in boys' perception of deprivation of privileges in parent's childrearing behaviours. Less deprivation of privileges may lead to expression of scientific creativity and thus, set the stage for development of originality among boys. It also implies that use of more deprivation of privileges to control children's behaviour may inhibit the development of originality among boys This interpretation shows that boys and girls may react differently to use of deprivation of privileges In our typical Indian culture girls are usually not allowed to exhibit deviant behaviours and are frequently exposed to such controlling behaviours as might have led to loss of their sensitivity to parental behaviours Inconsistency among such behaviours can be readily observed in connection with this aspect of parent-child interaction. On the other hand boys' deviant behaviours, unless they distort family tone, are tolerated Thus, they will react sharply to more deprivation of privileges if used by parents. Their oversensitivity may lead to development of greater anxiety or emotional tensions and these may block the growth of scientific creativity among boys

Column 9 of table 8.9 shows that there exists no significant relationship between rejection in home environment as perceived by boys and their scientific creativity, fluency, flexibility, originality and inquisitiveness This implies that use of rejection may not lead to death of the creative potential among boys Observation of the table also reveals that use of decreasing amounts of rejection is not significantly related with the

development of more flexibility, originality and scientific creativity among girls, meaning thereby that use of more or less rejection does not matter much so far as development of scientific creativity in general and flexibility and originality in particular is concerned However, the relationships between girls' perception of rejection and their fluency and inquisitiveness are significant at 05 and .01 levels respectively. This implies that use of more rejection may stifle girls' fluency and inquisitiveness while their perception of decreased rejection may be conducive to the growth of fluency and inquisitiveness.

Further analysis reveals that rejection as perceived by children may influence the growth of fluency and inquisitiveness among girls while it may remain ineffective in hindering or promoting the development of these abilities among boys These may be the results of differences in sensitivity to perceived rejection. Girls appear to be more sensitive to parental rejection This phenomenon can be easily observed in our daily life Thus, use of conditional love recognizing that girls have no rights as persons, no rights to express their feelings, no right to uniqueness and no right to become autonomous individuals may lead to emotional tensions and negative attitudes towards scientific creativity may develop. If so, fluency and inquisitiveness may be the aspects that may be more affected by rejection This aspect of school environment has not been found to be associated with any aspect of scientific creativity in particular and overall scientific creativity in general

Observation of column 10 of table 8.9 reveals existence of positive and significant correlations between perceived nurturance in home environment and boys' inquisitiveness , and girls' fluency, flexibility, originality and scientific creativity. This means that boys' perception of increasing levels of nurturance may be conducive to the development of their inquisitiveness in the field of science, and girls' perception of increasing levels of nurturance may lead to the development of their fluency, flexibility, originality and scientific creativity Findings of studies done by Terman (1954), McCurdy (1957), Greenacre (1958), Weisberg & Springer (1961), Ellinger (1964), Nuttal (1964), Heilbrun (1971), Wade (1971) and Moore & Bulbulian (1976) support our finding that perception of more nurturance may help the growth of scientific creativity among girls

Correlations between boys' perception of nurturance and their fluency, flexibility, originality and scientific creativity are not significant at 05 level Similarly, girls' inquisitiveness does not exhibit significant relationship with their perception of nurturance. These results imply that perception of

more nurturance by boys may not influence the development of their scientific creativity in general and their fluency, flexibility and originality in particular. Girls' perception of more or less nurturance may neither help nor inhibit the development of their inquisitiveness These findings are contrary to the findings of studies done by Silverberg (1970) with respect to fluency. He and Nuttal (1964) have also reported that no positive relationship exists between parental acceptance and children's creativity

Further analysis of the table and our discussion reveal interesting facts Nurturance is significantly and positively correlated with fluency, flexibility, originality and scientific creativity among girls while in case of boys correlations between these variables are not significant. Boys' inquisitiveness is significantly correlated with their perception of nurturance in home environment but in the case of girls, this positive and significant relationship does not exist This implies that more nurturance may lead to the development of more fluency, flexibility and originality and as a result of this more scientific creativity among girls Less nurturance, if perceived so by girls, will stifle their fluency, flexibility, originality and thereby, their scientific creativity However, perception of neither more nor less nurturance by boys, will significantly influence their fluency, flexibility, originality and scientific creativity Perception of neither more nor less nurturance may influence development of inquisitiveness among girls. However, more nurturance may lead to the development of more inquisitiveness among boys. These may be the reflections of unsatisfied needs pertaining to belongingness, seeking parent's attention, interest and love In our society most of the boys succeed in seeking more parental love and attention. Parents are interested in their welfare and harmoneous development They are supposed to be the integral members of the family and are seen as transmitters of family traditions or culture. Girls usually get less attention and interest as exhibited by parents who generally do not feel much concerned with the development of girls In comparison to boys, girls receive less parental affection and feel less belongingness with the family members. Hence, it is quite possible that girls who perceive more nurturance in their parents' childrearing behaviour, will be satisfied and this satisfaction will lead to free expression of their scientifically creative behaviours On the other hand girls with unsatisfied needs may fail to develop their scientific creativity in general and their fluency,flexibility and originality in particular. Our finding that nurturance may not be associated with the development of inquisitivenesss among girls may be the reflection of the commonly observed behavioural consistency among parents in which girls' behaviour of asking questions to know more about a phenomenon is usually not liked. Thus,

creative girls might have learnt when and how to express their inquisitiveness and therefore, they might have succeeded in developing their inquisitiveness In our society, boys are usually encouraged to be more inquisitive. Thus, if their inquisitiveness is discouraged or not reinforced by their parents, their inquisitiveness may fail to develop because of their frustration with parental behaviour which may lead to emotional disturbances.

It is interesting to note that acceptance in school environment as perceived by boys has been found to be negatively associated with flexibility, an aspect of scientific creativity Its relationships with overall scientific creativity and its fluency, originality and inquisitiveness aspects among boys as well as girls have been insignificant. Girls' flexibility may not be influenced by the increasing levels of acceptance in teachers' behaviour Thus, home environment appears to be more stimulating for girls. It may be immaterial whether girls perceive increasing levels of acceptance in their schools However, parents' behaviour should indicate that girls in the family are accepted by them. For boys, less acceptance in school environment and more acceptance in home environment may be conducive to the development of scientific creativity.

Observation of Column 11 of table 8 9 reveals that the correlations between permissiveness, as perceived by girls in their home environment, and their fluency, flexibility, originality, inquisitiveness and scientific creativity are not significant at 05 level. This finding draws support from the results obtained by Nuttal (1964), Ornstein (1961) and Silverberg (1970) It implies that more permissiveness if granted by parents and perceived so by girls, may not guarantee development of their scientific creativity and various aspects of it. It also indicates that less permissiveness may not stifle scientific creativity. This may be the outcome of inconsistency in parental behaviour regarding provision of opportunities to girls to express their views freely and act according to their desires with no interference from parents Commonly observed childrearing practices show that girls are subjected to more interference by parents Further, structure of our society does not allow more permissiveness for girls. Such social conditions might have forced the highly creative girls to adapt to low level permissiveness and learn how to perform scientific work creatively when less permissiveness is allowed to them. Their greater achievement motivation, higher level of aspiration, more intellectual energy, ability to make deliberate and systematic analysis in the early stages of a problem or task situation, reflective conceptual style and their readiness to express impulses and imaginative thoughts through conscious thought or in active

assertive ways might have helped them to express and develop their scientific creativity

Examination of the contents of the table shows that permissiveness as perceived by boys is positively correlated with scientific creativity and its four aspects Out of the five correlations two are not significant at 05 level meaning thereby that perception of more permissiveness may or may not be associated with fluency and flexibility among boys. The remaining three correlations between boys' perception of permissiveness in their home environments and their originality, inquisitiveness and scientific creativity are significant at .05, .01 and .05 levels respectively. This indicates that more permissiveness may ensure the development of boys' scientific creativity in general and their originality and inquisitiveness in particular In other words, less permissiveness, if perceived so by boys, will stifle scientific creativity among them This can be explained with reference to our experiences in parent-child interaction in natural situations. Boys usually desire the freedom to express their views and act according to their desires They dislike parental interference in their activities This does not mean that parental assistance at some crucial choice point will not be welcomed by them. However, if boys are not in need of this type of interference, this interference may evoke sharp reactions and tensions may develop among boys. These tensions compel boys to act according to their parent's instructions and curb their creative potential This might have been the case with our subjects too. Their perception of less permissiveness might not have enabled them to set the stage for the development of scientific creativity while behavioural consistency in permissiveness as granted by parents and perceived by boys might have generated a climate in which expression of scientifically creative behaviours could have been possible. Anderson and Anderson (1965), in a cross-cultural study of creativity among elementary and junior high school children, have found that creative expression is more frequent in cultures characterized by less authoritarian attitudes toward childrearing and social relationships This finding supports our results.

Permissiveness in school environment as perceived by girls has been found to be insignificantly correlated with their overall scientific creativity and its various aspects. However, in case of boys increasing levels of permissiveness were found to be negatively correlated with originality aspect of scientific creativity. Relationships between permissiveness on one hand and overall scientific creativity and fluency, flexibility and inquisitiveness aspects of it on the other have been insignificant,

Thus, more permissiveness, if perceived so by boys in their school environment, may inhibit the growth of originality among them while permissiveness in home environment may be conducive to the development of originality and inquisitiveness aspects of scientific creativity in particular and overall scientific creativity in general These may be the reflections of the effects of interactions of permissiveness aspect of home/school environment with the inner need systems that exist in boys

Summary

Our efforts to study relationship between perceived home environment on the one hand, and overall scientific creativity and various aspects of it, *viz.* fluency, flexibility, originality and inquisitiveness on the other have revealed that (1) inquisitiveness among boys is positively related with perceived environment, (2) overall scientific creativity and two aspects of it, *viz* fluency and originality, are positively related with home environment as perceived by girls The relationship between perceived home environment and inquisitiveness among boys was found to be relatively independent of the influence of extraversion However, this relationship has been found to be tied with the level of neuroticism, verbal intelligence, nonverbal intelligence and socio-economic status Relationship between perceived home environment, and fluency, originality and overall scientific creativity among girls has been found to be tied with verbal intelligence, nonverbal intelligence, socioeconomic status and extraversion The relationships have been found to be relatively independent of the effects of neuroticism.

Study of relationship between various aspects of perceived home environment on the one hand and scientific creativity and various aspects of it on the other has revealed that—

1. nurturance in home environment is positively related with overall scientific creativity and fluency, flexibility, and originality among girls. Such a significant positive relationship failed to appear in case of boys whose inquisitiveness was positively related with nurturance ,

2 protectiveness in home environment is positively and significantly related with inquisitiveness among girls For boys this relationship was significant but negative ;

3. conformity (decreasing levels) has negative but significant relationship with inquisitiveness among boys. In the case of girls this relationship has been insignificant ;

4 in case of boys increasing levels of permissiveness have positive but significant relationship with overall scientific creativity and originality and inquisitiveness aspects of it. In case of girls, permissiveness was not found to be significantly related with any aspect of scientific creativity.

5. deprivation of privileges (decreasing levels) aspect of home environment has a positive but significant relationship with originality among boys. Girls' scientific creativity was not at all related with this aspect of perceived home environment.

6 perception of decreasing levels of rejection is positively related with inquisitiveness among girls. In case of boys rejection has not been found to be related with any aspect of scientific creativity

Findings pertaining to relationship of various aspects of perceived home as well as school environment with overall scientific creativity and various aspects of it reveal that boys' scientific creativity is likely to be influenced by their perception of creative stimulation, cognitive encouragement, acceptance and permissiveness in school environment ; and permissiveness, protectiveness, conformity, nurturance and deprivation of privileges in home environment. It also appears that girls' scientific creativity may be influenced by nurturance, protectiveness and rejection in home environment. This indicates the idiosyncratic nature of environmental conditions.

Effect of Home and School Environment on the Development of Scientific Creativity

The previous chapter of the book was devoted to the analysis and discussion of the relationship between various aspects of scientific creativity and children's perception of home and school environments In the present chapter an attempt has been made to study the effect of high, normal or low levels of stimulation in school environment on the scientific creativity of boys or girls perceiving high, normal or low level stimulation in their home environment In order to achieve this purpose it was necessary to classify sample subjects in nine criterion groups. These groups are ·

S N	Criterion group	Abbreviation
1	Highly stimulating school and highly stimulating home	SHS & HHS
2	Highly stimulating school and normally stimulating home	SHS & HNS
3	Highly stimulating school and less stimulating home	SHS & HLS
4	Normally stimulating school and highly stimulating home	SNS & HHS
5	Normally stimulating school and normally stimulating home	SNS & HNS
6	Normally stimulating school and less stimulating home	SNS & HLS
7	Less stimulating school and highly stimulating home	SLS & HHS
8	Less stimulating school and normally stimulating home	SLS & HNS
9	Less stimulating school and less stimulating home	SLS & HLS

In order to form the criterion groups first and third quartiles were found out on the basis of frequency distribution of scores obtained by students on

the two environment inventories. The calculated values of Q_1 and Q_3 for school environment index scores were 134 4 and 173 5 respectively Boys whose scores were 134 or less were included in the category of those who perceive less than normal level stimulation in their school environment (SLS) Boys who scored equal to or more than 174 on the School Environment Inventory were included in the category of those who perceive high level stimulation in their schools Boys having a score more than 134 but less than 174 on this inventory were included in the SNS group (*i.e* group consisting of those children who perceive normal level stimulation in their schools) The calculated Q_1 and Q_3 values for home environment index scores of boys were 192 63 and 235.56 respectively. Boys who scored 193 or less were included in the group of those who perceive less than the normal level stimulation in their home environment (HLS) while those obtaining a score equal to or greater than 236 constituted the group of subjects perceiving greater stimulation in their home environment (HHS) The group of boys perceiving normal level stimulation in home environment (HNS) was constituted by boys who scored more than 193 but less than 236 on Home Environment Inventory. This procedure was followed in case of boys belonging to SHS, SNS and SLS groups. Thus, nine criterion groups were formed.

The calculated values of Q_1 and Q_3 for girls' scores on the School Environment Inventory were 145 59 and 178.55 respectively So girls scoring equal to or less than 146 constituted the SLS group while those with a score equal to or greater than 179 were included in the SHS group. The SNS group consists of girls who scored in between 146 and 179 After having formed three groups on the basis of Q_1 and Q_3 for school environment, each one of them was subdivided into three groups on the basis of the level of stimulation perceived by girls in home environment. The calculated values of Q_1 and Q_3 for scores on Home Environment Inventory were 205 75 and 242.95 respectively Thus, girls scoring equal to or greater than 243 were included in the HHS group while those obtaining a score equal to or less than 206 were included in the HLS group. Girls whose scores were more than 206 but less than 243 were included in the HNS group. Thus, nine criterion groups were formed for girls too.

After forming nine criterion groups of boys as well as girls, data on scientific creativity of boys and girls were separately analysed to find out whether boys or girls belonging to various groups differ with respect to their scientific creativity.

Table 9 1 *Sum of ranks and H—values showing differences in scientific creativity of students perceiving same or different levels of stimulation in home and school environments*

R N.	Groups Compared	Sex	N	Sum of ranks for					H—Values for				
				FL	FX	ORG	INQ	OSC	FL	FX	ORG	INQ	OSC
1	SHS & HHS	Boys	4	49.0	55.5	55 0	56 0	56 0					
	SNS & HNS		12	131 5	125 0	123 5	136 5	122 5	2681	1 0700	9746	2 3932	1 1629
	SHS & HLS		5	50.5	50 5	52 5	38 5	52 5					
2	SHS & HHS	Boys	11	282 0	282 0	293 5	335 0	291 5					
	SNS & HNS		30	876 5	868 0	850 5	782 5	874 5	1 6305	1 2020	5 4200	0405	1 8093
	SNS & HLS		12	272.5	281.0	253 0	310 5	265 5					
3	SLS & HHS	Boys	7	75 5	81 0	83 5	76 5	81 0					
	SLS & HNS		9	86 5	84 5	78 0	101 0	83 0	1 4774	1 2389	2 3878	0242	1 5462
	SLS & HLS		5	69.0	65 5	69 0	53 5	67 0					
4	SHS & HHS	Girls	6	77 5	79 5	80 0	83 0	79 0					
	SHS & HNS		10	136 5	131 0	131 0	103 0	131 0	2 7753	4151	4578	1.6713	3753
	SHS & HLS		8	86 0	89 5	89 0	114 0	90 0					
5	SNS & HHS	Girls	12	420 0	391 5	435 5	395 5	422 5					
	SNS & HNS		28	707 0	759 5	711 0	685 5	726 0	5 5943	5.0125	7 8738*	2 8320	6 8440*
	SNS & HLS		12	251 0	227.0	231.5	297 5	229 5					
6	SLS & HHS	Girls	10	160 0	138 5	158 0	114 5	155 0					
	SLS & HNS		8	92 0	115 5	94 5	95 5	93 5	1 7885	3997	1 4865	3 3792	1 1977
	SLS & HLS		8	99 0	97 0	98 5	141 0	102 5					

*Significant at 05 level

FL=Fluency, FX=Flexibility, ORG=Originality, IN=Inquisitiveness, OSC=Overall Scientific Creativity

Observation of table 9.1 shows that out of 30 H-values, 28 are not significant at .05 level because the probability associated with the occurrence under H_0 of a value as large as each of the 28 calculated values is greater than 05. It means that boys perceiving high/normal/low stimulation in school environment but various levels of stimulation in their home environment do not differ from one another in their overall scientific creativity as well as fluency, flexibility, originality and inquisitiveness aspects of it However, girls perceiving high or low stimulation in school environment and various levels of stimulalion (*i.e* , high, normal or low) in their home environment do not differ in their overall scientific creativity and fluency, flexibility, and inquisitiveness aspects of it. Fluency, flexibility, and inquisitiveness scores of girls perceiving normal level stimulation in their school environment do not vary significantly with their perception of various levels of stimulation in home environment These findings indicate that perception of high or low stimulation in school environment may not influence the development of fluency, flexibility and inquisitiveness among students perceiving different levels of stimulation in home environment Perception of normal level stimulation in school environment may not influence scientific creativity (overall as well as four aspects of it) of boys perceiving various levels of stimulation in home environment Development of fluency, flexibility and inquisitiveness among girls perceiving normal stimulation in their schools is not affected by the level of stimulation they perceive in their home environment.

Two H-values calculated in order to find out whether scientific creativity and originality of girls perceiving normal stimulation in their schools vary significantly with their perception of various levels of stimulation in their home environment are 6 8440 and 7.8738 respectively. These values are significant at 05 level. Thus, scientific creativity as well as originality scores of girls perceiving normal level stimulation in school environment vary significantly with their perception of stimulation in home environment In other words, it indicates that development of scientific creativity as well as originality among girls perceiving normal level stimulation in school environment may be influenced by their perception of various levels of stimulation in home environment Further analysis was done to find out which of the three levels of stimulation in home environment is likely to promote the development of originality and overall scientific creativity among girls Analysis was done by computing U-values.

Table 9.2 *Sum of ranks and U-values showing differences in scientific creativity among SNS group girls perceiving high, normal and low level stimulation in home environment*

S N	Groups compared	N	Sum of ranks	U-value	Z-value
1	SNS & HHS vs. SNS & HNS	12 28	306 5 513.5	107 5	1 7858
2	SNS & HLS vs. SNS & HNS	12 28	201.5 618 5	212.5	1 3138
3.	SNS & HHS vs SNS & HLS	12 12	194 0 106.0	28*	—

* significant at .01 level

Observation of table 9.2 shows that under null hypothesis the probability associated with occurrence of a Z-value equal to 1.7858 or 1 3138 is .0734 or .1902 respectively. These probabilities are greater than 05. This leads to the acceptance of the null hypothesis, indicating existence of no significant difference in the scientific creativity of girls perceiving normal stimulation in school environment but high or normal/normal or low level stimulation in their home environment Thus, as compared to normal stimulation in home environment, perception of high stimulation in home environment may not be much conducive to the development of scientific creativity among those girls that perceive normal level stimulation in school environment. As compared to less stimulation in home environment, perception of normal level stimulation in the home may not foster the development of scientific creativity among girls perceiving normal level stimulation in school environment Further look at the table shows that the third U-value (=28) is significant at .02 level because it is less than 31, the value given in table K of Siegel's *Nonparametric Statistics*. This allows us to reject the null hypothesis—Girls perceiving normal stimulation in school environment but low or high stimulation in home environment do not differ with respect to their scientific creativity. Further examination of the table helps us to conclude that as compared to girls perceiving low stimulation in home environment and normal stimulation in school environment, girls perceiving high stimulation in home environment but normal level of stimulation in school environment are higher in scientific creativity. It implies that as compared to low

level stimulation, high level stimulation in home environment, if perceived so by girls who perceive normal stimulation in school environment, may be more conducive to the development of scientific creativity among them.

Table 9. 3 *Sum of ranks and U-values showing difference in originality among SNS group girls perceiving high, normal and low level stimulation in home environment*

S.N.	Groups compared	N	Sum of ranks	U-value	Z-value
1.	SNS & HHS Vs. SNS & HNS	12 28	318.5 401.5	95 5	2 1456*
2	SNS & HLS Vs. SNS & HNS	12 28	204 5 615.5	209 5	1.2252
3.	SNS & HHS Vs. SNS & HLS	12 12	195 0 105.0	27**	——

**/* Significant at .02/.05 level

Observation of table 9.3 shows that the probabilities associated with occurrence of a value of Z equal to 2.1456 (for U=95.5) and 1 2252 (for U=209.5) are <.0316 and <.2186. The former value is less than 05 while the latter is greater than this. So, only the former value is significant. This enables us to conclude that originality of girls perceiving normal or low stimulation in home environment but normal stimulation in school environment is the same. Girls perceiving normal stimulation in school environment but high stimulation in home environment are higher in originality than girls who perceive normal stimulation in school as well as home environment. It implies that as compared to normal level stimulation, high level stimulation in home environment, if perceived so by girls perceiving normal stimulation in their school environment may be more conducive to the development of originality among them The nonsignificant Z-value permits us to conclude that girls perceiving normal stimulation in school environment but low or normal stimulation in home environment are alike so far as their originality is concerned. This means that as compared to normal stimulation in home environment, effect of low stimulation in home environment may not be too pronounced to inhibit the development of originality

The third U-value is 27 It is significant at 02 level because it is less than 31, the critical value required for significance at .02 level for a two-tailed test This enables us to reject the null hypothesis—'Girls perceiv-

ing normal stimulation in school environment but low or high stimulation in home environment do not differ with respect to their originality.' The conclusion is that girls perceiving normal stimulation in school environment but high stimulation in home environment are higher in originality than girls who perceive low stimulation in home environment but normal stimulation in school environment. It implies that high stimulation in home environment, if perceived so by girls perceiving normal stimulation in their school environment, may be more conducive to the development of originality among them than the high level stimulation in home environment

Summary

Discussions of various tables, as enumerated earlier shows that scientific creativity scores in general and scores on fluency, flexibility, originality and inquisitiveness in particular among boys perceiving high, normal or low stimulation in school environment, do not vary with the level of perceived stimulation in home environment. This indicates that perception of different levels of stimulation in home environment may not significantly influence the development of scientific creativity and its aspects, *viz* fluency, flexibility, originality and inquisitiveness among boys perceiving low, normal or high stimulation in school environment Now the question arises in our mind "Why have the low creative individuals failed in developing their scientific creativity in highly stimulating home and school environment ?" When we consider the views of Torrance and Myers (1970), it becomes clear that lack of guided and planned learning activities designed to promote scientific creativity in particular may be responsible for significant effects of good and normal stimulation as perceived in home or school environment on the development of scientific creativity. Guilford (1964) has argued very strongly that creativity utilizes distinct intellectual abilities generally falling within the broad category of what he called 'divergent thinking'. That is, creativity involves as a necessary condition the ability to branch out from the known and conventionally accepted behaviours to make new combinations of ideas which are original, adaptive to some problem and could not be predicted in advance simply through knowledge of the area under consideration. Lack of such abilities in the low creative children may be responsible for no effect of greater stimulation on the development of their scientific creativity. Guilford (1963) thinks · "development scientists and engineers, being continually concerned with practical problems that call for single best solutions, are over impressed with the need for convergent thinking" He reports that scientists appreciate the importance of producing changes (transformation) in their thinking, that is, of being free from "functional fixedness" These views indicate that differences in scientific creativity among boys may owe

their origin to differences in their intelligence, personality and socio-economic status This aroused curiosity in the investigator to find out whether the highly creative boys differ from the low creative boys in their intelligence, neuroticism, extraversion and socio-economic status This curiosity led to the analysis of data about verbal as well as nonverbal intelligence, socio-economic status, neuroticism and extraversion of boys perceiving equal amount of stimulation in home as well as school environment

Table 9.4 : *Differences in verbal intelligence scores of boys with high or low scientific creativity perceiving equal amount of stimulation in home and school environment*

C.I.	f_H	f_L	Cum. f_H	Cum. f_L	$S_{26H}(X)$	$S_{26L}(X)$	$\lvert S_{26H}(X)-S_{26L}(X)\rvert$
90—94	6	0	26	26	26/26	26/26	0
85—89	9	0	20	26	20/66	26/26	6/26
80—84	3	0	11	26	11/26	26/26	15/26
75—79	0	2	8	26	8/26	26/26	18/26
70—74	4	1	8	24	8/26	24/26	16/26
65—69	1	1	4	23	4/26	23/26	19/26
60—64	1	0	3	22	3/26	22/26	19/26
55—59	1	6	2	22	2/26	22/26	20/26
50—54	0	8	1	16	1/26	16/26	15/26
45—49	0	2	1	8	1/26	8/26	7/26
40—44	0	3	1	6	1/26	6/26	5/26
35—39	0	3	1	3	1/26	3/26	2/26
30—34	1	0	1	0	1/26	0/26	1/26

$K_D=20$

H=Boys with high scientific creativity
L=Boys with low scientific creativity

Observation of the table 9.4 reveals that the calculated value of K_D is 20, the numerator of the largest discrepancy between the two series. Table L of Siegel reveals that when N=26, a value of K_D=20 is significant at .01 level for a two tailed test Thus, verbal intelligence scores of LSC boys are significantly lower than those of HSC boys In other words, boys with high or low scientific creativity will differ with respect to their verbal intelligence It implies that low creative boys are less intelligent than highly creative boys

Table 9.5 *Differences in nonverbal intelligence scores of boys with high or low scientific creativity perceiving equal amount of stimulation in home and school environment*

C I	f_H	f_L	Cum f_H	Cum. f_L	$S_{26}H(X)$	$S_{26}L(X)$	$\lvert S_{26}H(X)-S_{26}L(X)\rvert$
29—31	1	0	26	26	26/26	26/26	0
26—28	0	0	25	26	25/26	26/26	1/26
23—25	6	2	25	26	25/26	26/26	1/26
20—22	9	4	19	24	19/26	24/26	5/26
17—19	6	5	10	20	10/26	20/26	10/26
14—16	2	8	4	15	4/26	15/26	11/26
11—13	1	3	2	7	2/26	7/26	5/26
8—10	1	3	1	4	1/26	4/26	3/26
5—7	0	1	0	1	0/26	1/26	1/26

K_D=11

Table 9 5 shows that the value of K_D (=11) is significant at 05 level This allows us to say that significant differences exist in the nonverbal intelligence of boys with high or low scientific creativity. It means that nonverbal intelligence of low scientifically creative boys is less than that of highly scientifically creative boys perceiving equal stimulation in their home as well as school environment. It implies that low nonverbal intelligence may be responsible for low scientific creativity among boys who perceive the same degrees of stimulation in home and school environments. Majumdar's (1973) suggestion that it will be of great practical value to use a simple, short, nonverbal test of intelligence for screening candidates for

creativity testing from among the general higher secondary science students—the cutoff point being fixed at +1S.D. of the population, also supports our result.

Table 9.6 *Differences in neuroticism among boys with high or low scientific creativity perceiving equal amount of stimulation in home and school environment*

C.I.	f_H	f_L	Cum. f_H	Cum. f_L	$S_{26}H(X)$	$S_{26}L(X)$	$\mid S_{26}H(X)-S_{26}L(X) \mid$
35—37	2	2	26	26	26/26	26/26	0
32—34	1	0	24	24	24/26	24/26	0
29—31	1	2	23	24	23/26	24/26	1/26
26—28	0	3	22	22	22/26	22/26	0
23—25	1	3	22	19	22/26	19/26	3/26
20—22	5	5	21	16	21/26	16/26	5/26
17—19	4	2	16	11	16/26	11/26	5/26
14—16	3	4	12	9	12/26	9/26	3/26
11—13	4	1	9	5	9/26	5/26	4/26
8—10	1	4	5	4	5/26	4/26	1/26
5—7	2	0	4	0	4/26	0/26	4/26
2—4	2	0	2	0	2/26	0/26	2/26

$K_D = 5$

Table 9.6 shows that the value of K_D (=5) is not significant at .05 level. Thus, we can say that there is no significant difference in the neuroticism of highly creative and low creative boys perceiving the same stimulation in home as well as school environment. It means that as compared to low creative boys, those with high scientific creativity are ~~not~~ more neurotic. It indicates that neuroticism may not be responsible for differences in scientific creativity among boys perceiving the same amounts of stimulation in their home and school environments

Observation of table 9.7 reveals that the value of K_D is 3 which is not significant at .05 level. This allows us to infer that no significant difference exists in the extraversion of highly creative and low creative boys perceiv-

ing the same stimulation in home as well as school environment It means that as compared to highly creative boys, the low creative boys are not much low in extraversion. It implies that if the same amount of stimulation is perceived in home as well as school environment, extraversion will not influence the development of scientific creativity among the highly creative or the low creative boys

Table 9.7 *Difference in extraversion between high and low creative boys perceiving equal amount of stimulation in home and school environment*

C. I.	f_H	f_L	Cum. f_H	Cum f_L	$S_{26}(X)_H$	$S_{26}L(X)$	$\mid S_{26}H(x)-S_{26}L(X) \mid$
36—37	1	0	26	26	26/26	26/26	0
34—35	2	3	25	26	25/26	26/26	1/26
32—33	2	3	23	23	23/26	23/26	0/26
30—31	3	1	21	20	21/26	20/26	1/26
28—29	4	5	18	19	18/26	19/26	1/26
26—27	3	2	14	14	14/26	14/26	0/26
24—25	2	4	11	12	11/26	12/26	1/26
22—23	1	3	9	8	9/26	8/26	1/26
20—21	2	1	8	5	8/26	5/26	3/26
18—19	1	2	6	4	6/26	4/26	2/26
16—17	4	1	5	2	5/26	2/26	3/26
14—15	1	1	1	1	1/26	1/26	0

$K_D=3$

Table 9 8 shows that the value of K_D (=10) is significant at .05 level. This means that there exists significant difference in the socio-economic status of highly creative and low creative boys perceiving the same stimulation in home and school environments. It means that as compared to low creative boys, highly creative boys come from homes of high socio-economic status. It implies that if boys perceive same amount of stimulation in home and school environments, the SES of their homes may influence their scientific creativity.

Table 9.8 *Differences in socio-economic status of high and low creative boys perceiving equal amount of stimulation in home and school environment*

C.I	f_H	f_L	Cum f_H	Cum.f_L	$S_{26H}(X)$	$S_{26L}(X)$	$\mid S_{26H}(X)-S_{26L}(X) \mid$
70—74	1	0	26	26	26/26	26/26	0
65—69	4	1	25	26	25/26	26/26	1/26
60—64	3	5	21	25	21/26	25/26	4/26
55—59	6	0	18	20	18/26	20/26	2/26
50—54	4	5	12	20	12/26	20/26	8/26
45—49	4	1	8	15	8/26	15/26	7/26
40—44	1	5	4	14	4/26	14/26	10/26
35—39	0	1	3	9	3/26	9/26	6/26
30—34	1	1	3	8	3/26	8/26	5/26
25—29	1	2	2	7	2/26	7/26	5/26
20—24	1	3	1	5	1/26	5/26	4/26
15—19	0	2	0	2	0/26	2/26	2/26
			$K_D=10$				

Thus, we may conclude that as compared to home and school environment as perceived by boys, their socio-economic status and their intelligence (verbal as well as nonverbal) might have been responsible for bringing about differences in scientific creativity.

In case of girls, our earlier discussions indicate that development of scientific creativity in general and its various aspects in particular among girls perceiving high or low stimulation in school environment will not be affected by differences in their perception of high/normal/low stimulation in home environment It has been found that fluency, flexibility and inquisitiveness scores of girls perceiving normal stimulation in school environment do not vary with the level of stimulation perceived in home environment. So far as development of originality in particular and scientific creativity in general are concerned, our findings indicate that as compared to low stimulation in homes, high level stimulation in homes (if they are perceived so by the girls) may lead to the development of more scientific creativity among girls perceiving normal stimulation in school environment Results of a study done by Sagar and Kaplan (1972) support our finding. They reported that greatest influence on the development and perpetuation of individual behaviour is exerted by the family

Creative Students' Perception of Home and School Environments

Individuals affect and are affected by the environment. Vinacke (1952) recognized that learning always involves interplay between the organism and the environment. Both organism and environment are extremely complex and therefore, the possibilities for their interaction are unlimited The combinations of conditions are always different for any two individuals. The internalization of experience equips the individual with particular ways of perceiving, feeling, acting and thinking It results in the establishment of more or less permanent selecting and regulating systems which together make up a complex system determining the direction, characteristics and content of behaviour-symbolic as well as overt. This system is composed of innumerable subsystems and represents the effects of past experience and the means whereby past experiences continue to influence present activity.

Thus, Vinacke has pointed to different effects of a set of characteristics (*i.e.* combinations) of perceived environment on learning. This is relevant for the development of scientific creativity because our findings in the previous section have indicated that boys' scientific creativity is likely to be influenced by their perception of creative stimulation, cognitive encouragement, acceptance and permissiveness in school environment ; and protectiveness, deprivation of privileges. nurturance and permissiveness in home environment. However, girls' perception of nurturance, rejection and protectiveness in home environment may influence their scientific creativity So, girls appear to be immune to the effects of other aspects of home environment, *viz*. control, punishment, reward, conformity, social isolation, deprivation of privileges and permissiveness, as perceived by them. It points to the probability of differences in the amounts of stimulation perceived by children with high and low scientific creativity. In the present chapter it is proposed to explore differences in home and school environments as perceived by boys or girls with high and low scientific creativity In order to achieve this two groups of boys/girls with high and low scientific creativity were formed,

10.1 Formation of criterion groups

Value of skewness given in the table 10 1 (S_K=.583) shows that the distribution of scientific creativity scores obtained by boys is positively skewed. The calculated values of Q_1 and Q_3 are 68 46 and 119 92 respectively. Thus, boys who scored equal to or more than 120 were included in the group of boys with high scientific creativity, whereas the group of boys exhibiting low scientific creativity was constituted by boys who scored either 69 or less on Tests of Scientific Creativity.

Table 10 1 *Distribution of boys' scientific creativity scores*

Class Interval	f	Statistical values
205—224	2	Q_1= 68 46
185—204	3	Q_3=119.92
165—184	2	Mean=97.18
145—164	5	Median=89 24
125—144	9	S.D.=40 89
105—124	12	Skewness=.583
85—104	19	
65— 84	24	
45— 64	15	
25— 44	3	
5— 24	1	

Table 10.2 *Distribution of girls' scientific creativity scores*

Class Interval	f	Statistical values
245—264	1	Q_1=107 4
225—244	2	Q_3=173 8
205—224	10	Mean=143 72
185—204	5	Median=139 17
165—184	14	S D =42 94
145—164	15	Skewness=.318
125—144	15	
105—124	17	
85—104	19	
65— 84	4	

Table 10 2 shows that the distribution of scientific creativity scores of girls is positively skewed (S_K=.318) The calculated values of Q_1 and Q_3 are 107 4 and 173 8 respectively Thus, girls who scored equal to or greater than 174 were included in the group of girls with high scientific

creativity while those who obtained scientific creativity scores equal to or less than 107 constituted the group of girls with low scientific creativity

After having formed the criterion groups, efforts were made to study whether children with high scientific creativity differ from those with low scientific creativity in their perceptions of school and home environments. Kolmogorov-Smirnov Two Sample Test was used to find out the existence of differences. Ogives were plotted to study the perceived school and home environments (overall and various aspects of them) of children with high or low scientific creativity

10 2 Differences in School Environment as Perceived by Children, with High and Low Scientific Creativity

Table 10 3 *Differences in HSC and LSC boys' perception of school environment (total perspective)*

C I	HSC Boys			LSC Boys			$\mid S_{25_1}(X) - {}_{25_2}(X) \mid$
	f_1	Cum. f_1	$S_{25}(X)$	f_2	Cum. f_2	$S_{25}(X)$	
197—206	2	25	25/25	0	25	25/25	0
187—196	0	23	23/25	4	25	25/25	2/25
177—186	0	23	23/25	1	21	21/25	2/25
167—176	5	23	23/25	6	20	20/25	3/25
157—166	1	18	18/25	6	14	14/25	4/25
147—156	3	17	17/25	3	8	8/25	9/25
137—146	5	14	14/25	2	5	5/25	9/25
127—136	2	9	9/25	2	3	3/25	6/25
117—126	3	7	7/25	0	1	1/25	6/25
107—116	2	4	4/25	1	1	1/25	3/25
97 - 106	0	2	2/25	0	0	0	2/25
87— 96	2	2	2/25	0	0	0	2/25

HSC—High Scientific Creativity
LSC—Low Scientific Creativity

Table 10 3 shows that the largest discrepancy between the two series is 9/25 The numerator of this largest difference is 9 and therefore, 9 becomes the value of K_D Reference to table L (Siegel, 1956) reveals that when N=25, a K_D value of 10 is significant at 05 level for a two tailed test. It indicates that the observed value of K_D is not significant at 05 level This enables us to accept the null hypothesis of 'no significant difference in the amount of stimulation in school environment as perceived by boys with high or low scientific creativity' Thus, HSC and LSC boys do not differ significantly from one another in their perception of stimulation in school environment

Obseivation of fig. 1 shows that HSC *boys'* ogive lies to the left of the LSC boys' ogive upto P_{92} where it ciosses the latter and then continues to lie to the right of it This shows that below P_{92} HSC boys perceive con-

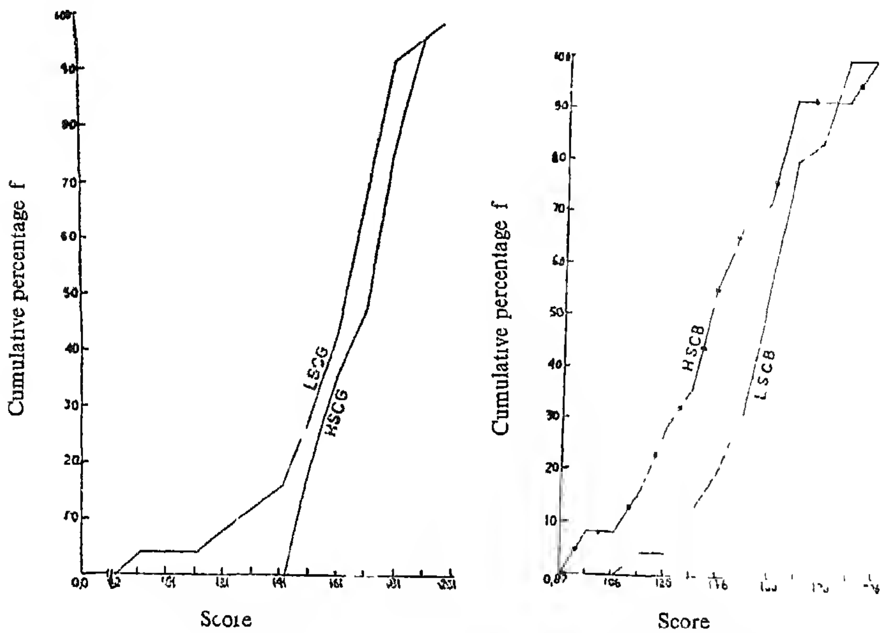

FIG 1 Ogives showing differences in HSC and LSC children's peiception of stimulation in School environment

ısistently low stimulation than the LSC boys. Q_1, median and Q_3 values foı ISC boys are approx. 124, 143 and 168 iespectively. Foı LSC boys these 'ues are approx. 150, 164 and 174 The two groups diffeı more at Q_1 stin , at either median or Q_3 Howeveı, these differences are not much diffeı upports ouı earlieı finding that HSC and LSC boys do not differ from school ther in their perceptions of stimulation in school envionment At P . Oboys perceive more stimulation in their school envionment than HSC boys. It indicates that low stimulation may not be conducive to the development of more scientific cieativity. It may not inhibit the development of it. Approximately 71 percent of HSC boys fall below LSC boys' median while about 17 percent of the LSC boys fall below the HSC boys' median

To sum up the above inteipretation, we can say that boys' perception of stimulation in school environment may neither piomote noı inhibit the development of scientific creativity among boys This draws support fiom our finding of existence of insignificant relationship between overall scientific creativity and school environment as perceived by boys (tau=—

.1015). Except originality, all the remaining aspects of scientific creativity were not found to be significantly related with perceived school environment. This reveals idiosyncratic effects of overall school environment on the development of scientific creativity among boys. Jones (1972) is quite correct in saying that quality of teacher-pupil interaction cannot always influence the development of creativity. He thinks—

> "The creative being does not emerge suddenly His development is gradual and takes place only in an atmosphere which allows him to express himself. The teacher must refrain from forcing creative growth , rather must he create conditions which allow creative work to develop. The actual moment when a child is creative and realises this, the creative leap cannot be induced by the teacher, but must be allowed for, and is most likely to occur in a particular kind of setting There must be no semblance of tyrannical authoritarianism in which spontaneity is denied nor yet too much license causing uncertainty and distraction."

If we were to observe the school environments, we shall rarely come across a school where teachers provide additional support or stimulation for the boys with high scientific creativity Usually situations inside and outside the school force them to refrain from establishing 'inequality in educational opportunities'. Students' scientific creativity usually does not guide teacher-pupil interaction in most of our schools. In view of such a situation, it is quite probable that boys with high or low scientific creativity will perceive the same amount of stimulation in school environment

Observation of table 10.4 shows that the largest discrepancy between the two series is 5/25, SO, 5, the numerator of this difference, becomes the value of K_D This value is not significant at 05 level. It means that HSC and LSC girls perceive the same amount of stimulation in schools. This indicates that girls' high or low scientific creativity does not influence teachers' behaviour to create stimulating environments for the students. Our finding that neither overall scientific creativity nor any aspect of it is significantly related with girls' perception of stimulation in school environment draws support from the present one

Observation of *girls'* ogives in fig 1 shows that HSC girls' ogive lies to the right of the LSC girls' ogive upto P_{96} where both coincide This shows that upto P_{96} HSC girls perceive consistently more stimulation than LSC girls Q_1 , Q_3 and median values for HSC girls are approx 154 5, 181 and 172 respectively. For LSC girls these values are approx.

Table 10 4 *Differences in HSC and LSC girls' perception of school environment (total perspective)*

C. I	HSC Girls			LSC Girls			$\lvert S25_1(X)—S25_5 (X) \rvert$
	f_1	Cum f_1	$S25_1$ (X)	f_2	Cum. f_2	$S25_2$(X)	
192—201	1	25	25/25	1	25	25/25	0
182—191	5	24	24/25	1	24	24/25	0
172—181	7	19	19/25	6	23	23/25	4/25
162—171	3	12	12/25	6	17	17/25	5/25
152—161	4	9	9/25	4	11	1/25	2/25
142—151	5	5	5/25	3	7	7/25	2/25
132—141	0	0	0	1	4	4/25	4/25
122—131	0	0	0	1	3	3/25	3/25
112—121	0	0	0	1	2	2/25	2/25
102—111	0	0	0	0	1	1/25	1/25
92—101	0	0	0	0	1	1/25	1/25
82—91	0	0	0	1	1	1/25	1/25

148.5, 174 5 and 163 5 respectively. The two groups differ more at median and less at Q_1 and Q_3. Nearly 39% of the HSC girls fall below LSC girls' median while about 70 5% LSC girls fall below HSC girls' median.

Thus, both the HSC and the LSC children perceive similar amounts of stimulation in their school environment An attempt was made to explore differences in HSC and LSC children's perception of various aspects of school environment Results of the attempt are presented in table 10 5

Observation of table 10.5 shows that none of the twelve values of K_D is significant at .05 level because each of them is less than 10, the critical value given in table L (Siegel, 1956) for a two tailed test They indicate existence of no significant difference in the amount of stimulation in school environment as perceived by HSC and LSC boys as well as girls. Boys or girls obtaining high or low scores on Tests of Scientific Creativity do not differ significantly from one another in their perception of creative stimulation, cognitive encouragement, acceptance, control, rejection and permissiveness in school environment In other words, boys' or girls' perception of various aspects of school environment may neither promote nor inhibit the development of scientific creativity among them,

Table 10.5 *Differences in various aspects of school environment as perceived by students with high and low scientific creativity*

S N	Aspect of school environment	Boys				Girls			
		K_D	C I $_K$	Cum f_H	Cum. f_L	K_D	C I.$_K$	Cum f_H	Cum f_L
1.	Creative stimulation	9	36—39	4	13	4	33—38	1	5
2	Cognitive encouragement	8	27—28	16	8	2	29—31	16	14
3	Permissiveness	7	23—25	20	13	4	26—28	18	22
4	Acceptance	5	20—22	22	17	4	17—18	7	11
5	Rejection	4	18—19	5	1	4	26—28	17	21
6	Control	8	16—18	12	20	5	13—14	17	12

K_D=the largest discrepancy between the observed cumulative step functions for HSC and LSC students
C I $_K$=Class interval in which K_D appears
Cum f_H=Cumulative frequency for HSC students in C.I $_K$
Cum f_L=Cumulative frequency for LSC students in C.I $_K$

Observation of fig. 2 shows that HSC and LSC boys' ogives start simultaneously and after P_8 the former lies to the right of the latter ogive throughout the range. It means that HSC boys perceive consistently

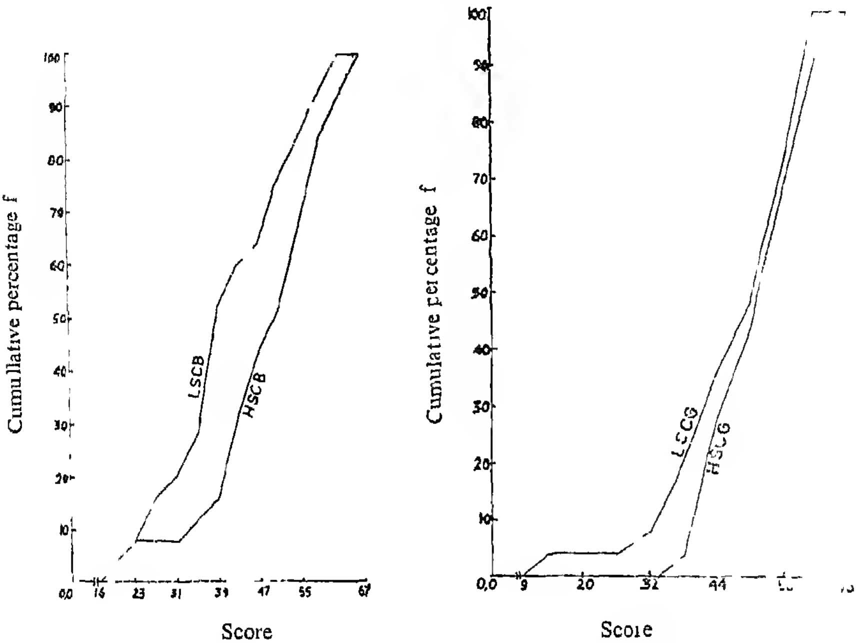

FIG 2 Ogives showing differences in HSC and LSC children's perception of creative stimulation in school environment

-eater amount of creative stimulation in their school environment than Ie LSC boys However, the differences between the two groups' percep- va of creative stimulation in school environment at Q_1, median and Q_3 than are approximately 8, 11 and 6 respectively. So, the two groups This score at median. Further examination of the ogive reveals that one and of LSC boys exceed the median of HSC boys while 16% of the HSC boys fall below the LSC boys' median *Girls'* ogives in this figure reveal that HSC girls perceive consistently greater creative stimulation in their SE* than the LSC girls. The differences between the two groups' perception of creative stimulation in SE at Q_1, median and Q_3 points are approx.** 3 3, 1.0 and 0.8 respectively Thus, the two groups differ more at Q_1 than at either median or Q_3 46% of HSC girls fall below the median for LSC girls. P_4 values for HSC and LSC girls are 38 and 14

*SE is the abbreviation for 'school environment'

**approx. stands for 'approximately.'

respectively. It indicates that very low creative stimulation may inhibit the development of scientific creativity among girls

Fig 3 shows that the HSC *boys'* ogive lies to the left of the LSC boys' ogive throughout its course It means that HSC boys perceive consistently low cognitive encouragement in their schools than LSC boys

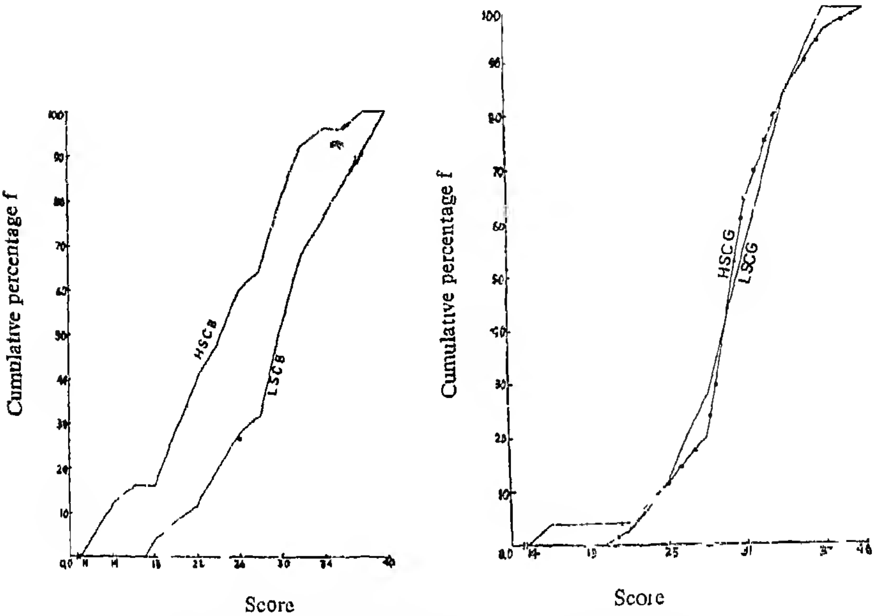

FIG 3 Ogives showing differences in HSC and LSC children's perception of cognitive encouragement in school environment

Difference between the two groups is greatest at Q_1 (=5.8) It decreases at median (=5.5) and Q_3 (=4.2). Approx 21.5% of the LSC boys fall below the median of HSC boys Ogives reveal an interesting phenomenon. It is that below the median, perception of low cognitive encouragement may be more conducive to the development of scientific creativity while more cognitive encouragement in schools, if perceived so by boys, may hinder the growth of scientific creativity Observation of the *girls'* ogive shows that HSC girls' ogive lies to the right of the LSC girls' ogive upto P_{42} where the former crosses the latter and then it lies to the left of LSC girls' ogive but at P_{81} it crosses the latter and then it continues to lie to the right of LSC girls' ogive About 54% of HSC girls fall below the LSC girls' median while 47 5% LSC girls fall below the median of HSC girls. Out of these 54% HSC girls only 18% (approx.) fall below the Q_1 of LSC girls Differences in the Q_1, median and Q_3 values for the two

groups are approx. 1.1, 0 4 and 0 5 respectively. These differences imply that perception of cognitive encouragement may neither promote nor inhibit the development of girls' scientific creativity

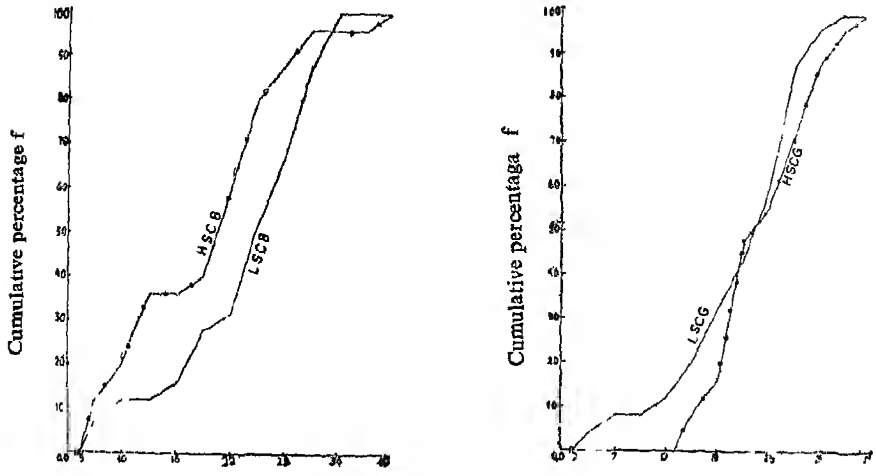

FIG 4 Ogives showing differences in HSC and LSC children's perception of permissiveness in school environment

Fig·4 shows that LSC boys' ogive lies to the right of HSC boys' ogive upto P_{96} after which the former continues to lie to the right of the latter. This means that below P_{96} HSC boys perceive consistently low permissiveness in their SE than LSC boys This indicates that HSC boys can develop their scientific creativity even when some stimulation is perceived by them because they have the motivation to do creative work or thinking in the field of science Q_1, median and Q_3 values for the two groups differ by 7.3, 4.3 and 4 5 respectively. Approx. 78 5% of the HSC boys fall below the LSC boys' median Now the curiosity arises as to what leads to the development of low scientific creativity among boys perceiving nearly the same amount of permissiveness in their SE. The answer may be hunched in the lack of strong motivation to express and perform creative thinking in science. The genetic constitution of boys with low scientific creativity, their attitude toward scientific creativity, their willingness to be absorbed in creative scientific thinking and their sensitivity to what happens in their classrooms may account for the development of low scientific creativity among boys perceiving more permissiveness in theii schools than the HSC boys Examination of *girls'* ogive in fig. 4 shows that HSC girls' ogive lies to the right of LSC girls' ogive upto P_{43} where it crosses the latter to lie on the right of it. At P_{52} the former ogive again crosses the latter ogive and then continues to

remain on the right side of the latter ogive. This reflects inconsistency in teachers' behaviour to permit free expression of views by students. Differences in permissiveness in SE as perceived by the two groups at Q_1, median and Q_3 points are 2.6, 0 5 and 1.8 respectively. Nearly 48% of the LSC girls fall below the HSC girls' median.

Examination of *boys'* ogives in fig. 5 indicates that below P_{96}, HSC boys consistently perceive more acceptance in their schools than the LSC boys Approx. 69.5% of the HSC boys fall below the LSC

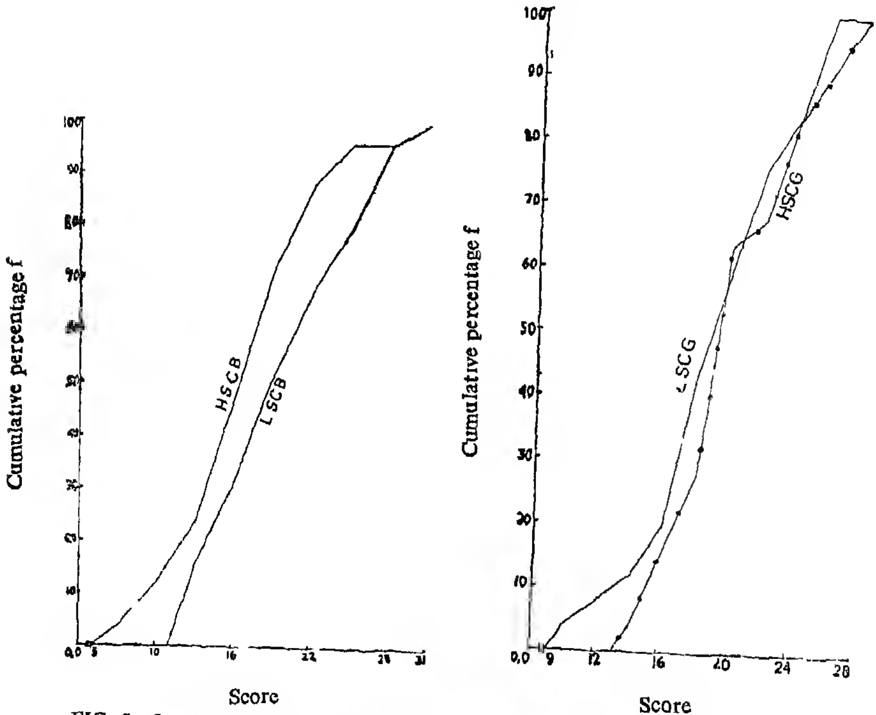

FIG. 5 Ogives showing difference in HSC and LSC children's perception of acceptance in school environment

boys' median. The differences in the amount of acceptance as perceived by the two groups is the least at Q_1 (=1 6). At median and Q_3 this difference is 2.5 and 4.5 respectively. Observation of *girls'* ogives in the figure 5 reveals inconsistency in teachers' unconditional love, recognizing that students have the right to express feelings, to uniqueness and to be autonomous individual (*i e* acceptance) as perceived by HSC and LSC girls Below P_{56} HSC girls perceive more acceptance than the LSC girls. The same observation is apparent beyond P_{68} but in between these two percentiles HSC girls perceive comparatively less acceptance than LSC girls. The differences in acceptance as perceived by the

members of the two groups at Q_1, median and Q_3 points are approx. 1.1, 0 5 and 1.0 respectively. These differences are too low to be significant. Approx. 54% of the LSC girls fall below the HSC girls median. Thus, both groups perceive nearly similar amounts of acceptance in school environment. This conclusion also holds truth in case of boys. Haddon and Lytton (1968, 1971) and Puranjoti (1972) reported that acceptance promotes the development of creativity among children. It appears that because of their greater sensitivity HSC children might have been satisfied with their teachers' behaviour and as a result of this satisfaction they might have succeeded in developing their scientific creativity.

Examination of *boys'* ogives in fig 6 shows that approx. 46 5% of the HSC boys fall below LSC boys' median Differences between Q_1, median and Q_3 values for the two groups are approx. 1.4, 0.5 and 1.1. In the

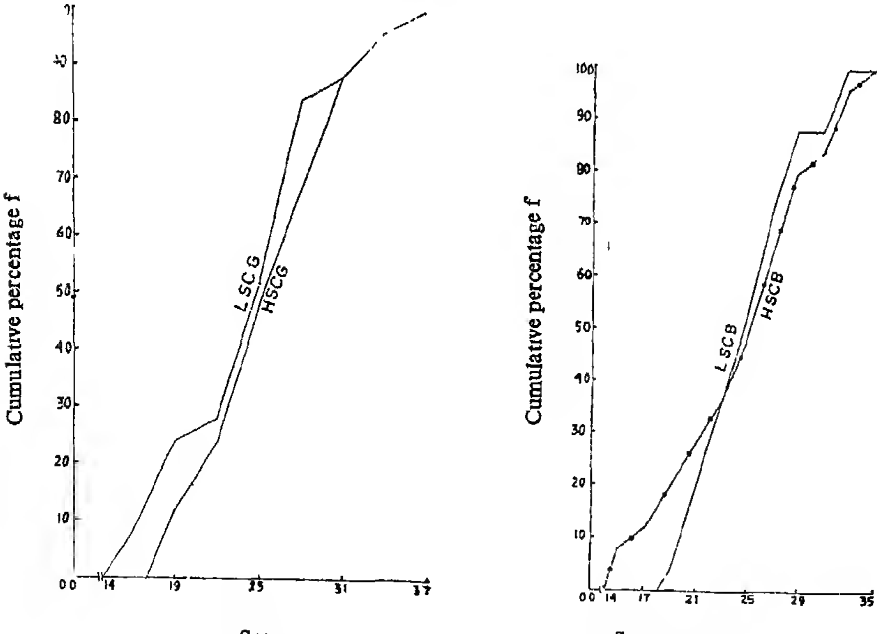

FIG. 6 Ogives showing differences in HSC and LSC children's perception of rejection in school environment

beginning the LSC boys' ogive lies to the right of HSC boys' ogive but at P_{36} it crosses the latter to lie to the left of it It indicates that below P_{36} HSC boys perceive more rejection than the LSC boys while beyond this point the former perceive more rejection than the latter This points to inconsistency in teachers' behaviour to recognize students' rights to deviate, act freely and be an autonomous individual. Thus, it may be difficult for

both HSC and LSC boys to predict when their creative behaviour in science will be rejected to some extent. This uncertainty might have enabled HSC boys to think creatively in the field of science They might have ignored rejection whenever it would have been exercised by their teachers Examination of *girls*' ogives shows that approx. 45 5% HSC girls fall below LSC girls' median. The differences between Q_1, median and Q_3 values for the two groups are approx. 2.4, 0.6 and 2 8 respectively. HSC girls perceive less rejection than LSC girls. However, this difference is too low to be significant Nearly similar findings have been reported in case of boys. Jone's (1972) observation appears to be relevant in the Indian context He said :

> "The child needs the support of the teacher in thinking and expressing ideas that are unconventional and unusual. The pupil must feel that he is not on trial as a person and that activity, individuality and personal differences are valued In contrast to the usual classroom situation, criticism must be postponed until after the actual production of ideas. Discrimination of the product is necessary, but the pupil must never be made to feel that because his ideas are rejected, he is also rejected as a person."

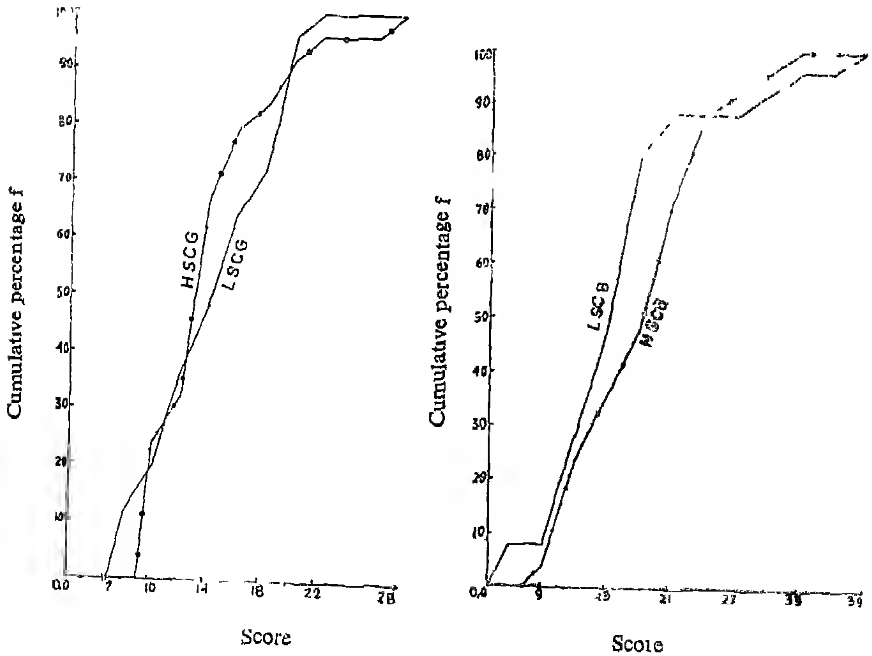

FIG. 7 Ogives showing differences in HSC and LSC children's perception of control in school environment

Observation of *boys'* ogives in fig 7 reveals inconsistency in teachers' behaviour to impose several restrictions on students to control them Below P_{88} HSC boys perceive less control in their SE than LSC boys. Beyond this LSC boys perceive consistently less control than HSC boys Approx. 81% LSC boys fall below HSC boys' median. Difference between Q_1, median and Q_3 values for the two groups are 0 8, 3.0 and 4 0 respectively. *Girls'* ogives in this figure reveal an interesting phenomenon HSC ogive, in the beginning, lies to the right of LSC girls' ogive but at P_{19} it crosses the latter to remain on its left upto P_{27} where it again crosses the LSC girls' ogive. Thereafter, HSC girls' ogive lies to the right of LSC girls' ogive upto P_{38} where it again crosses the latter to remain on its left. At P_{90} the former again crosses the latter and then it continues to lie to the right of it (LSC girls' ogive) This shows that teachers' behaviour to control girls' classroom behaviour is not consistent. This lack of consistency in imposing restrictions to discipline girls may have taught them to ignore teachers' controlling strategies so far as expression of creative behaviour is concerned. They might have been expressing and doing creative thinking in the field of science without being afraid of the possible control that may be exercised However, it appears that girls' perception of more or less control cannot motivate them to perform more creative thinking. This also holds truth in the case of boys

To sum up the above mentioned interpretations we can say that neither boys nor girls with HSC and LSC differ significantly in their perceptions of SE. This implies that our teachers do not try to create more stimulating conditions for HSC children. They appear to have faith in the principle of '*equal treatment to all*'. It will be proper to say that existence of stimulating climate in our schools only cannot guarantee the development of scientific creativity among children Wees (1971) has aptly remarked, "No body can teach anybody anything ' Our findings indicate that Torrance's comments on his experiments may be quite relevant in the Indian context. He (1972) said, "Our findings only indicate the relative low importance of facilitating conditions" Besides lending support to existence of no significant differences in children's perception of various aspects of school environment, our study of ogives has indicated that very low stimulation (overall) in the SE may inhibit the development of scientific creativity. Very low creative stimulation (*i.e* $<P_{18}$), permissiveness (*i e.* $<P_{15}$), acceptance (*i e* $<P_{10}$), rejection (*i e* $<P_{13}$) and control (*i.e* $<P_{16}$) appear to inhibit the development of scientific creativity among girls. However, in case of boys low levels of increasing quantity of cognitive encouragement and acceptance, and high levels of creative stimulation

appear to promote scientific creativity. Thus, schools can contribute to the development of scientific creativity among students but as Trabue (1962) thinks, we cannot ask teachers to create scientific creativity when it does not exist in larger amounts. Stimulating environment of school may promote the development of scientific creativity only when special enrichment programmes, vertical as well as horizoral are provided to students who can think creatively in science Teachers will have to discover this source of energy among children, reawaken it if it has been circumstantially suppressed, reassure it if it has been disturbed and redirect it if it has taken a blind direction. All this will demand work books, textbooks, provocative questions in the classroom and laboratory work which has been designed specifically to develop scientific creativity among students. It is to be remembered that only schools cannot encourage scientific creativity. Scientific creativity that the child has developed during his school life, cannot be attributed in entirety to the influence of school environment. Due account must be taken of the child's own genetic potentials. However, the embryo is endowed with the potentials for development and only a proportion of this potential is developed in a congenial environment. The degree of actualization may be a function of the perceived home environment.

10.3 Differences in Home Environment as Perceived by Children with High and Low Scientific Creativity

Studies of parent-child interactions (i.e. home environment) comprise a cluster of reports about background factors in creativity. Most frequently, these studies have involved a comparison of parents whose offsprings are high in creativity with parents whose offsprings show less creative promise (Evans & McCandless, 1978). The quality of the parent-child relationship has been thought of as causal correlation (Jensen, 1967) Coleman et al. (1966) have also emphasized the extent of home influence In the proceeding section an attempt is made to investigate whether children with high or low scientific creativity differ from one another in their perception of stimulation in home environment

Perusal of 'a' row of table 10.6 shows that calculated values of K_D are 5 (for boys) and 11 (for girls). The former is not significant at 05 level It means that HSC and LSC boys perceive nearly the same amount of stimulation in home environment It implies that boys' perception of increasing levels of stimulation in home environment may not be conducive to the development of scientific creativity among boys This draws support from our finding of existence of insignificant relationship

a	Total perspective	5	218—232	17	22	11*	214—223	6	17
b	Aspects of HE								
1	Control	6	13—14	1	7	3	20—22	14	17
2	Protectiveness	7	16—18	19	12	3	17—19	19	16
3	Punishment	5	12—13	9	14	4	17—18	13	17
4.	Conformity	8	9—11	23	15	5	11—13	15	20
5	Social isolation	10*	26—28	11	21	6	21—22	4	10
6.	Reward†	4	29—31	15	19	9	26—28	6	15
7	Deprivation of privileges	7	29—31	13	20	4	29—31	11	15
8	Nurturance†	6	20—22	12	18	12**	20—22	7	19
9.	Rejection	8	32—34	15	23	9	31—32	8	17
10	Permissiveness†	9	12—14	7	16	4	14—16	14	18

*/** Significant at 05/.01 level

† Except these three, other aspects of home environment (HE) have been negatively scored

between perceived home environment and scientific creativity. The latter K_D Value is significant at 05 level. This points to existence of significant differences between HSC and LSC girls' perception of home environment. HLC girls perceive more stimulation in their homes than LSC girls. It implies that girls' perception of more stimulation in home environment may be conducive to the development of scientific creativity among girls Our finding of existence of significant relationship between overall scientific creativity and perceived home environment (tau=.1741) also supports the present inference. Further observation of the table reveals that two out of 20 values of K_D are significant at .05 level. This indicates that both HSC and LSC boys as well as girls perceive similar amounts of control, protectiveness, punishment, conformity, reward, deprivation of privileges, rejection and permissiveness. HSC and LSC boys perceive similar quantities of nurturance while girls of these groups perceive equal amounts of social isolation in their home environment. HSC boys perceive less social isolation than LSC boys while HSC girls perceive more nurturance than LSC girls.

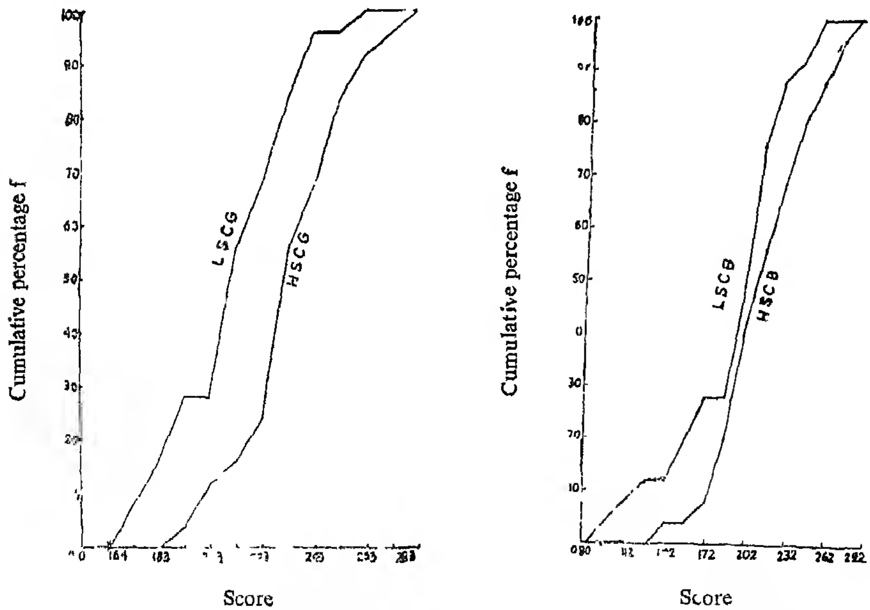

FIG 8 Ogives showing differences in HSC children's perception of stimulation in home environment

Obeservation of fig 8 shows that HSC *boys*' ogive lies to the right of the LSC boys' throughout its course P_4 value for the HSC boys is 97 while for the LSC boys it is 142. Difference between Q_1, median and Q_3 values

for the two groups are 24 5, 8 3 and 24 respectively About 41% of the HSC boys fall below the LSC boys' median Thus, HSC boys consistently perceive more stimulation in their home environment. *Girls'* ogives in the figure show that HSC girls' ogive lies to the right of LSC girls' ogive So, the HSC girls consistently perceive more stimulation in home environment than LSC girls Approx. 15.5% HSC girls fall below the median of LSC girls. The difference between Q_1, median and Q_3 values for the two groups are approx. 33, 20 and 20 respectively

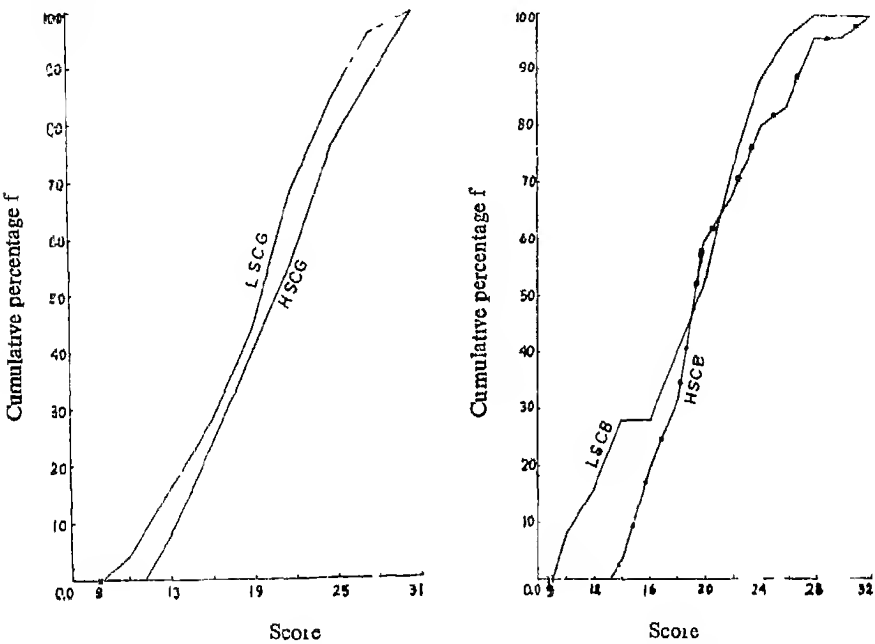

FIG 9 O gives showing differences in HSC and LSC children's perception of control in home environment

Fig 9 shows that after its origin HSC *boys'* ogive lies to the right of LSC boys' ogive, but at P_{46} the former crosses the latter and remains on the left upto P_{62} where it again crosses the latter and then continues to lie to the right of LSC boys' ogive. Thus, parents' behaviour to impose restrictions on boys in order to discipline them is not consistent. This inconsistency may be responsible for ineffectiveness of control in inhibiting scientific creativity Approx 55% HSC boys fall below LSC boys' median. Differences between Q_1, median and Q_3 values for the two groups are approx 3.3, 0.4 and 0.8 respectively. For *girls* these values differ by approx. 1 0, 1.2 and 1.6 After its origin HSC girls' ogive lies to the right of LSC girls' ogive throughout its course. This means that HSC girls

perceive less control in their home environment than LSC girls. This difference has been consistent. About 44% HSC girls fall below the LSC girls' median. Thus, it appears that decreasing amounts of control as perceived by boys or girls may not be conducive or inhibitive to the development of scientific creativity among them This is not consistent with the findings of Terman (1954), Roe (1960), Gallagher (1964), Ellinger (1964), Straus and Straus (1968), Heilbrin (1971) and Aldous (1975)

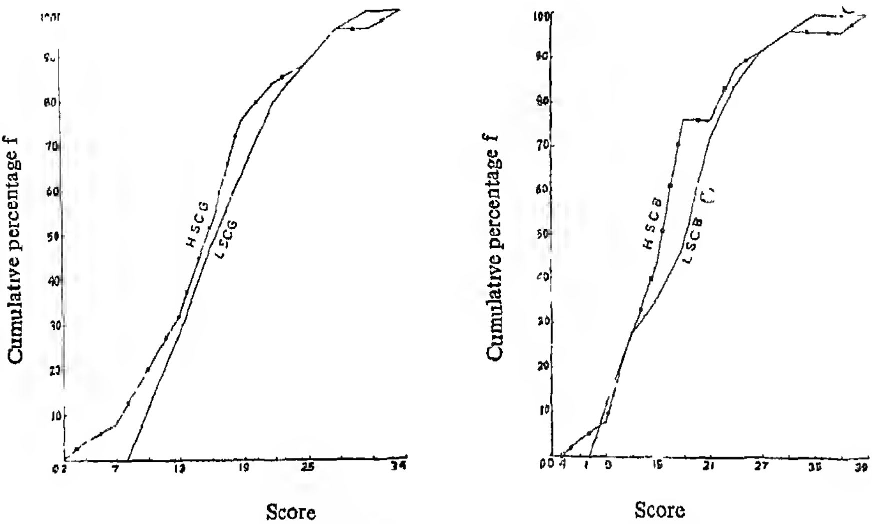

FIG 10 Ogives showing differences in HSC and LSC children's perception of protectiveness in home enviroment

Boys' ogives in fig. 10 show that in the beginning HSC boys' ogive lies to the right of LSC boys' but the former crosses the latter at about P_5 beyond which the former lies to the left of the latter. Both coincide at P_{92} but at P_{96} HSC boys' ogive crosses LSC boys' ogive to lie to the right of the latter Approx. 24% HSC boys exceed LSC boys' median. Q_1, median and Q_3 values for the two groups differ by 0.2, 2.8 and 3 8 respectively The differences are too small to be significant. Examination of *girls'* ogives reveals inconsistency in their perception of protectiveness in home environment 45% LSC girls exceed HSC girls' median. Differences in the Q_1, median and Q_3 values for the two groups are approx 1.2, 0 6 and 1.3 respectively Thus, children's perception of protectiveness in their home environment may not influence the development of scientific creativity. Our findings draw support from the study of MacKinnon (1965). However, results of studies done by Aldous (1975) and Roe (1960) contradict the present findings

Boys' ogives in fig 11 show, that below P_{88} the HSC boys' ogive lies to the right of the LSC boy's ogive At P_{88} the former touches the latter and then continues to remain on the right of it. These observations point

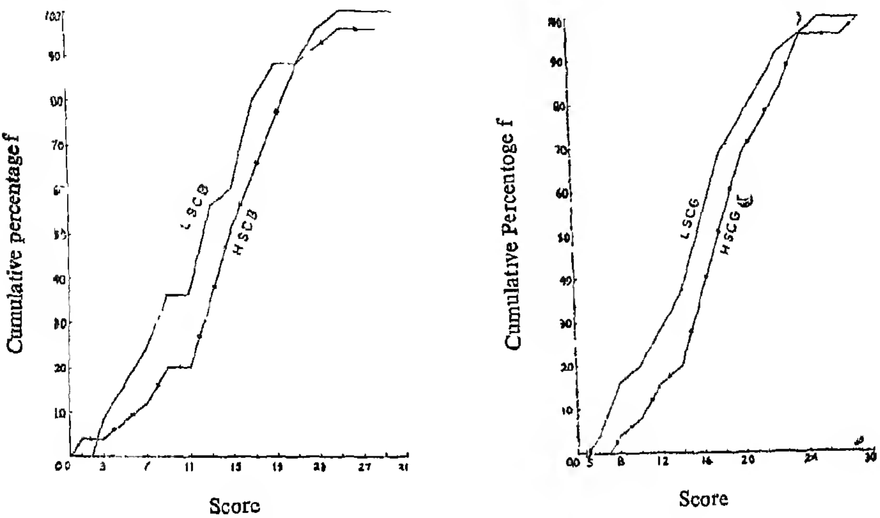

FIG 11 Ogives showing differences in HSC and LSC children's perception of punishment in home environment

to the conclusion that HSC boys continue to perceive less punishment than LSC boys. Thus, parental behaviour appears to be consistent About 30% HSC boys fall below LSC boys' median At Q_1, median and Q_3 the differences between the two groups are approx. 4.5, 2 5 and 2.3 For *girls'* these differences are approx. 3.4,2 1 and 2.0. HSC girls' ogive lies to the right of LSC girls' ogive throughout its course except at P_{96} where both coincide. Thus, HSC girls perceive less punishment in their home environment Approx 34% LSC girls exceed HSC girls' median

Observation of *boys'* as well as *girls'* ogives in fig 12 reveals inconsistency in parental behaviour to demand work according to their desire and expectation Upto P_{38} HSC boys perceive less conformity in their home environment but below P_{96} the former perceive more conformity Beyond P_{96} both of them perceive nearly equal amounts of conformity. Approx 44% LSC boys fall below HSC boys' median. Differences between the Q_1, median and Q_3 values for the two groups are 1 3, 1.2 and 4 4 So, beyond Q_3, boys' perception of less conformity in home environment may promote the development of scientific creativity Upto P_{84} HSC girls perceive less conformity than LSC girls. Below P_{96} HSC girls perceive more conformity than LSC girls whereas beyond this point LSC girls perceive more conformity than HSC girls. About 42% LSC girls exceed the HSC girls' median.

Differences in Q_1, median and Q_3 values are approx. 1 5, 0 8 and 2 7. These differences are not much. Thus, the role of conformity, as perceived by boys as well as girls in their home environment, is an indecisive one

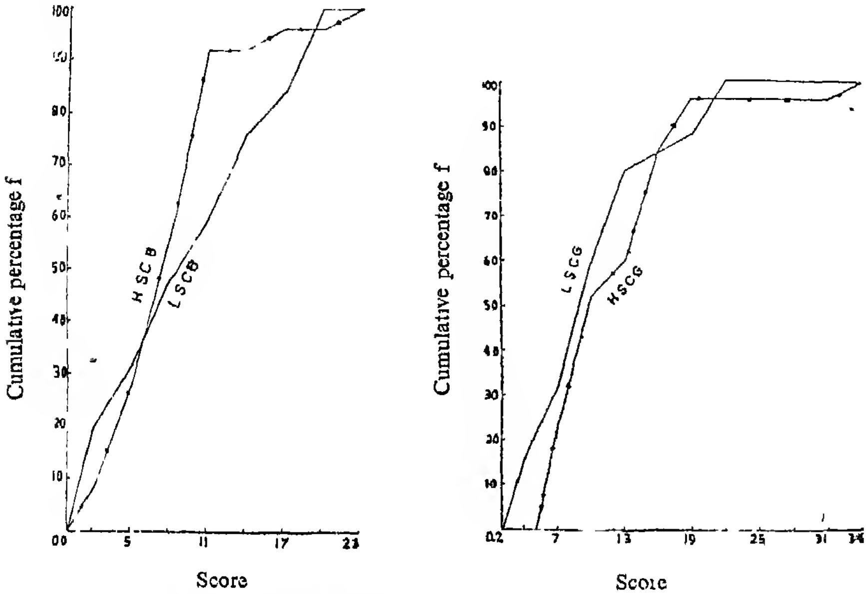

FIG 12 Ogives showing differences in HSC and LSC children's perception of conformity in home environment

This is contrary to the results of studies done by MacKinnon (1965), Aldous (1975), Stein (1963), Dryer and Wells (1966) and Mari (1973). Tripathi (1980) has discussed importance of conformity to parents' demands Its origin lies in our ancient culture according to which heaven, duty and divinity are all concentrated in the male parent. If he is pleased, all Gods remain pleased Thus, our boys and girls seem to have learnt to preserve and nurture their scientific creativity despite compliance to parents' wishes In the Western society it is believed that conformity to parents' wishes may stifle children's ability to think creatively. We do agree with Prof Tripathi who thinks that too much emphasis on conformity inhibits creative thinking Perhaps such a stress is lacking in our homes of today

Examination of *boys'* ogives in fig 13 shows that HSC boys' ogive lies to the right of LSC boys' ogive Approx 35% of the HSC boys fall below the median for LSC boys. Differences between Q_3 and median values for the two groups (*i.e.*=6.9,5 7) are larger than the difference between Q_1 values (*i.e.*=3 0) Thus, as compared to LSC boys, HSC boys con-

sistently perceive less social isolation in their home environment It implies that boys' perception of less social isolation (=its decreasing amounts) in home environment may be conducive to the development of

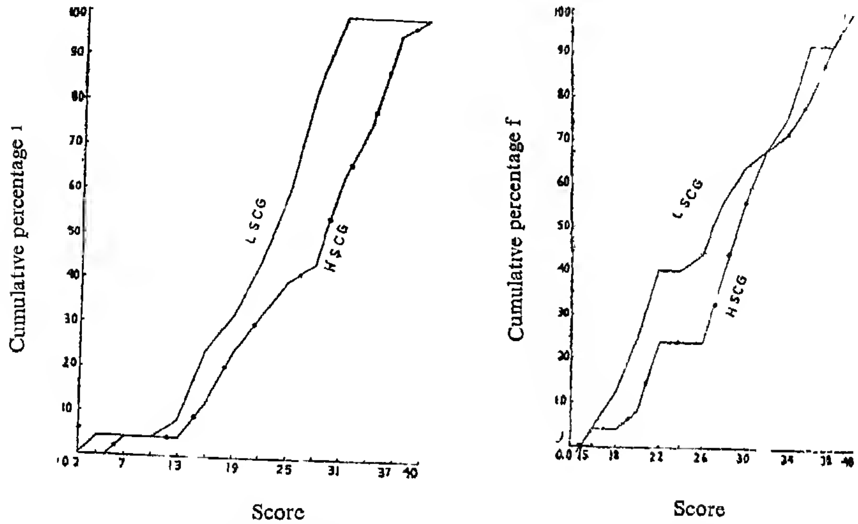

FIG 13 Ogives showing differences in HSC and LSC children's perception of social isolation in home environment

scientific creativity It is interesting to note that this implication does not hold truth because the relationship between these two variables, *viz.* decreasing quantities of social isolation and boys' scientific creativity, has not been found to be significant at 05 level The curiosity to know why these findings contradict each other arises. We think that LSC boys may be less sensitive to the social isolation as used by parents or they might have learnt to adapt to such conditions in homes and as a result of adaptation LSC boys might have developed immunity to social isolation. HSC boys because of greater sensitivity, might have succeeded in thinking creatively in an environment which is characterized by use of less social isolation This hunched answer to the above mentioned question points to the idiosyncratic effects of social isolation in home environment. It appears that use of less social isolation may promote scientific creativity among HSC boys but it may neither speed up nor retard the rate of development among LSC boys Observation of *girls'* ogives shows that HSC girls' ogive lies to the right of LSC girls' ogive except at P_{68} and P_{92} where both coincide Nearly 32 5% HSC girls fall below LSC girls' median Differences between Q_1, median and Q_3 values for the two groups are 6 0, 2 2 and 0.2 respectively This indicates that upto P_{68} HSC

girls perceive less social isolation than LSC girls. Now a question arises in our mind Why do both HSC and LSC girls perceive same amounts of social isolation in their home environment ? The answer to this question may be hunched in our cultural context. We usually see that girls are allowed to have less contacts with other children and persons outside the family Most of the girls are sensitive to this type of treatment from parents They do not want to be isolated from the beloved persons, if they exist at all. So, they will perceive whatever isolating devices are used by their parents as negative sanctions Girls' scientific creativity does not influence use of these devices by many parents.

Boys' ogives in fig 14 point to inconsistency in parents' behaviour to use material as well as symbolic rewards. About 41% LSC boys exceed

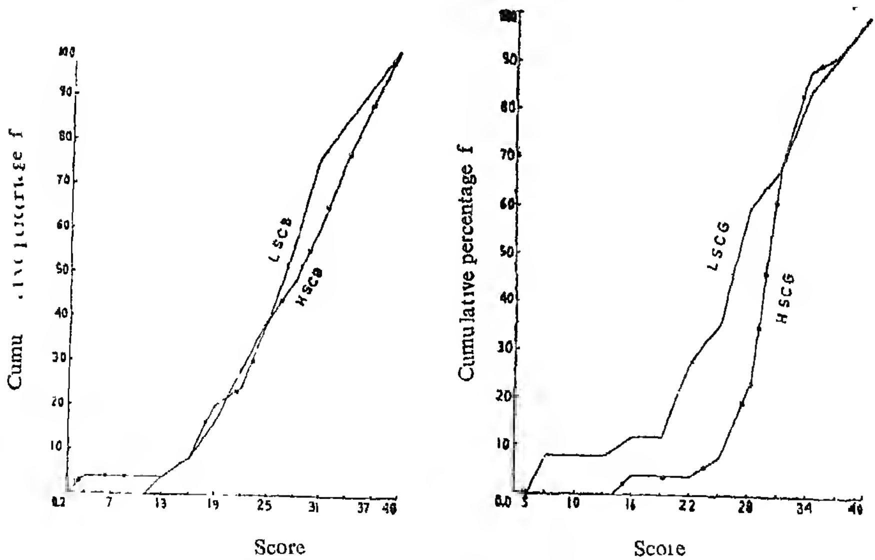

FIG 14 Ogives showing differences in HSC and LSC children's perception of reward in home environment

HSC boys' median. Differences between Q_1, median and Q_3 values are approx 0.9, 1.6 and 2.9 respectively These differences are quite small but they disclose that parents use rewards for boys more frequently. This frequent use of rewards might have led to the development of decreased sensitivity among boys toward the rewards and consequently rewards have lost their stimulating value. Thus, it appears that if one makes frequent

and indiscriminate use of rewards for increasing the probability of desired behaviour, scientific creativity may not develop to a higher level. Observation of *girls'* ogives shows that upto P_{68} HSC girls' ogive lies to the right of LSC girls' ogive, meaning thereby that below this point HSC girls perceive consistently more rewards in their home environment than LSC girls. At P_{68} HSC girls' ogive crosses LSC girls' ogive and then continues to remain on the left of the latter upto P_{92} where both coincide. Approx 65% of LSC girls fall below HSC girls' median while 17% HSC girls fall below LSC girls' median. The differences between Q_1, median and Q_3 values for the two groups are 6 7, 3 0 and 0.2. The first one is quite large and indicates that below this point HSC girls perceive more rewards in their home environment than LSC girls.

Observation of *boys'* ogive in fig 15 shows that below P_{92} HSC boys' ogive lies to the right of LSC boys' ogive meaning thereby that below P_{92} HSC boys consistently perceive less deprivation of privileges than LSC

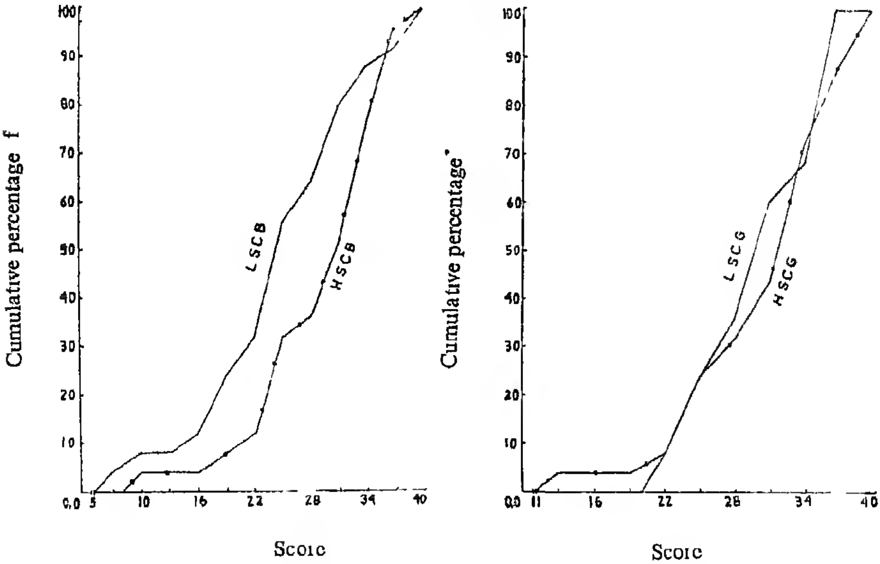

FIG 15 Ogives showing differences in HSC and LSC children's perception of deprivation of privileges in home environment

boys At P_{92} the HSC boys' ogive crosses the LSC boys' ogive and then it continues to remain on the left of it. It means that beyond this point LSC boys perceive less deprivation of privileges in their home environment than the HSC boys Approx 22% LSC boys exceed HSC boys' median. The difference between the two groups is quite large at median (=6 0) It implies that at this point HSC boys perceive less deprivation of

privileges than LSC boys At Q_1 and Q_3 these differences are approx 4.5 and 3 9 respectively. In the beginning LSC *girls'* ogive lies to the right of HSC girls' ogive At P_8 the former crosses the latter and thereafter it remains on the left of HSC girls' ogive. At about P_{67} the former again crosses the latter. This also reoccurs at P_{96} after which the former lies to the left of HSC girls All these observations disclosed inconsistency in parent's behaviour to deprive their daughters of their rights to seek love, respect and childcare from them. Approx 38% LSC girls exceed HSC girls' median Differences between Q_1, median and Q_3 values are approx 0 1. 1 9 and 0.2 respectively. These differences are quite low and indicate existence of no significant difference between the two groups

Observation of *boys'* ogives in fig. 16 reveals that about 9% of HSC boys perceive less nurturance than LSC boys This implies that development of scientific creativity among these HSC boys might not have been influenced by their perception of less nurturance in home environment. In

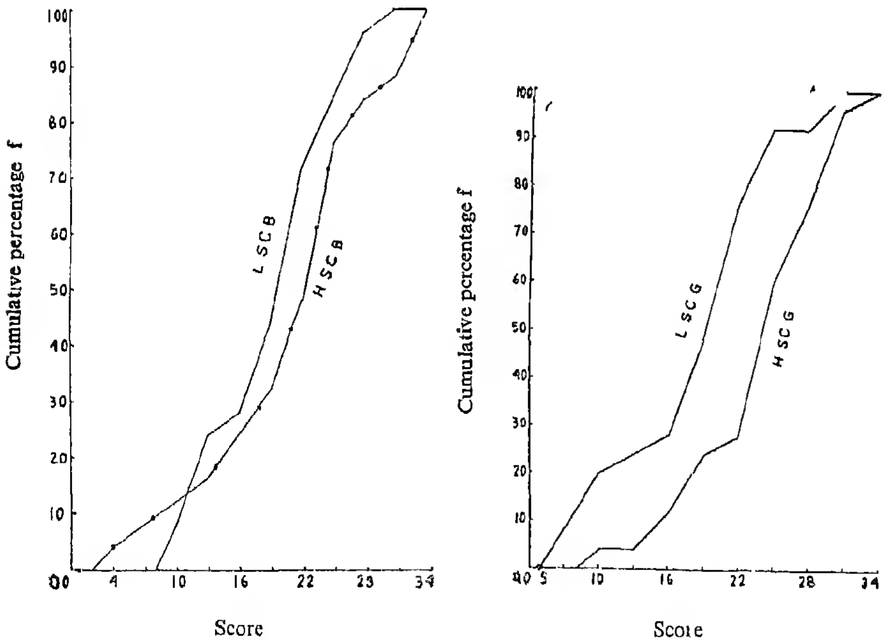

FIG 16 Ogives showing differences in HSC and LSC children s perception of nurturance in home environment

the beginning HSC boys' ogive lies to the left of LSC boys' ogive At P_{13} HSC boys' ogive crosses the LSC boys' ogive and then it continues to lie to the right of it. So, beyond P_{13} HSC boys perceive more nurturance than LSC boys. These observations point to inconsistency in parental

behaviour to observe unconditional physical and emotional attachment with boys About 35% HSC boys fall below LSC boys' median. Differences between Q_1, median and Q_3 values for the two groups are approx 2.8, 2.5 and 2.1 respectively. These differences are too small to be significant. Thus, both HSC and LSC boys perceive nearly the same quantity of nurturance in home environment. It implies that boys' perception of increasing amounts of nurturance may neither promote nor inhibit the development of scientific creativity among boys. This draws support from the findings of Nuttal (1964) and Silverberg (1970). However, findings of McCurdy (1957), Greenacre (1958), Wade (1971), Heilbrin (1971) and Dewing and Taft (1973) present a contradictory position in connection with general creativity among children. Examination of *girls'* ogives shows that HSC girls' ogive lies to the right of LSC girls' ogive throughout its course. This indicates that HSC girls consistently perceive more nurturance in home environment than LSC girls About 24% HSC girls fall below LSC girls' median. Difference between the two groups are quite large at Q_1 (=6.0), median (=4 8) and Q_3 (=5 9). Thus, as compared to LSC girls, HSC girls perceive more nurturance (It implies that girls' perception of more nurturance in their home environment may contribute to the development of scientific creativity among girls This draws support from our finding that scientific creativity among girls is positively related to perceived nurturance. Considering the above findings it seems that more nurturance in home environment may promote the development of scientific creativity among girls, and may neither promote nor inhibit the development of this potential among boys. This idiosyncratic effect may be explained on the basis of girls' needs and sensitivity which again are linked with our cultural traditions prevalent in Hindu homes)

In fig 17 HSC *boys'* ogive lies to the right of LSC boys' ogive throughout its course. About 21% LSC boys exceed the median of HSC boys. Differences between Q_1, median and Q_3 values for the two groups are approx 3 0, 4 6 and 5.5 respectively Difference is larger at Q_3 than either at Q_1 or median. This indicates that HSC boys perceive consi-

stently less rejection than LSC boys. HSC *girls'* ogive lies to the right of LSC girls' ogive This indicates that HSC girls perceive consistently less rejection than LSC girls. About 28% HSC girls fall below LSC girls'

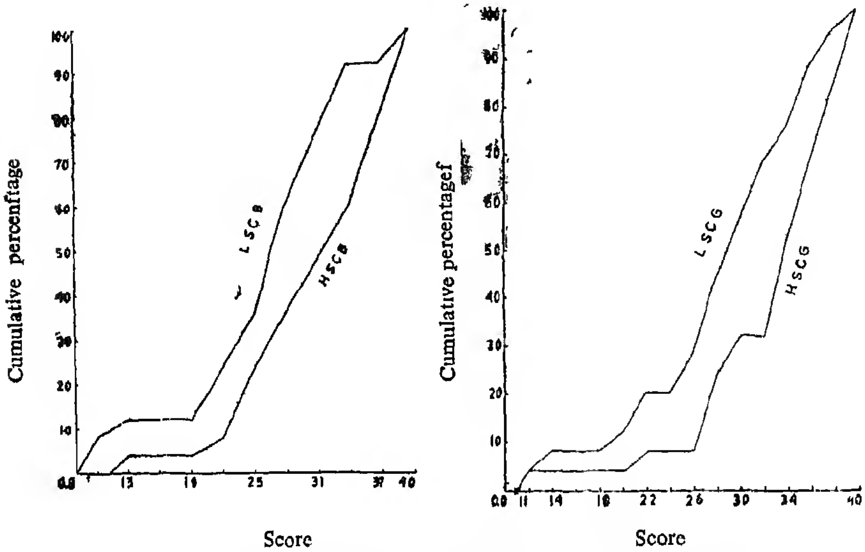

FIG 17 O gives showing differences in HSC and LSC children's perception of rejection in home environment.

median. Differences between Q_1, median and Q_3 values for the two groups are 4 8, 3 0 and 3.1 respectively These differences are too low to be significant. Studies by Moore and Bulbulian (1976) and Stein (1963) do not support the conclusions

Observation of *boys'* ogives in fig. 18 shows that HSC boys' ogive lies to the right of LSC boys' ogive throughout its course except at P_{96} where both touch each other. About 23% HSC boys fall below LSC boys' median. Differences between Q_1, median and Q_3 values for the two groups are approx. 3.6 5.5 and 2 2 respectively. The difference in median is quite large Thus, as compared to LSC boys HSC boys perceive consistently more permissiveness. On the whole this difference appears to be insignificant. It means that boys' perception of increasing or decreasing levels of permissiveness may neither promote nor inhibit the development of scientific creativity Our boys usually crave for permissiveness If their need is not satisfied, they may fail to think creatively Lack of permissiveness in home environment may lead to the development of frustration, decreased motivation and emotional disturbances which may inhibit the development of scientific creativity. However, if some

amount of permissiveness is allowed, HSC boys may perceive it and because of their creative motivation, genetic composition or greater sensitivity they may succeed in developing their scientific creativity. It is correct to

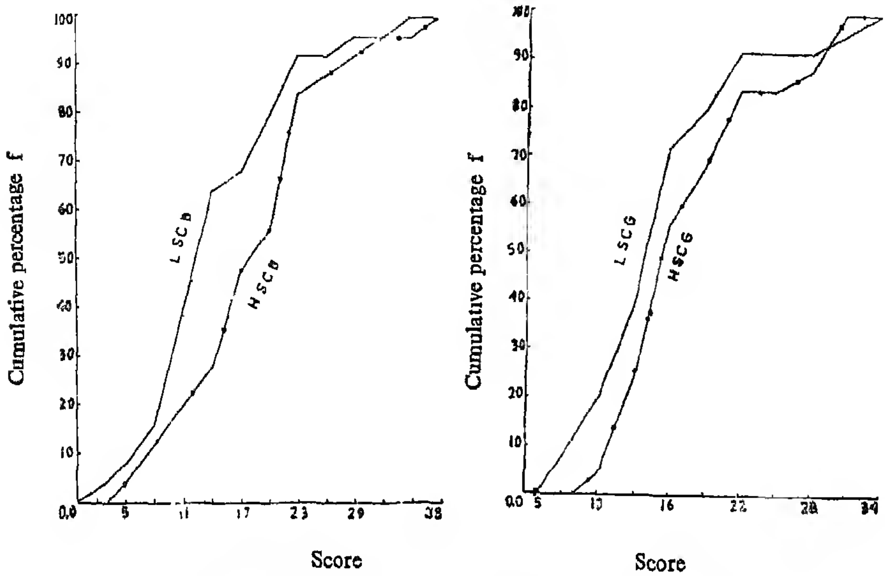

FIG 18 Ogives showing differences in HSC and LSC children's perception of permissiveness in home environment

say that even if too much permissiveness is allowed to exist in home environment, only those boys who possess the motivation and ability to think creatively in science and are more sensitive, will be able to think creatively. This discussion points to the idiosyncratic effects of increasing amounts of permissiveness on the development of scientific creativity among boys A look at the *girls'* ogives shows that upto P_{94} HSC girls' ogive lies to the right of LSC girls' ogive, meaning thereby that throughout this range girls with high scientific creativity perceive more permissiveness in their home environment than LSC girls. At P_{94} the former crosses the latter to lie on the left of LSC girls' ogive. This indicates that beyond P_{94} HSC girls perceive less permissiveness than LSC girls. These observations reveal inconsistency in parent's behaviour to provide opportunities to girls to express their views freely and act according to their desires with no interference from parents. About 34% LSC girls exceed HSC girls' median. Differences between Q_1, median and Q_3 values for the two groups are approx. 2 4, 1.4 and 3 2 respectively. These are too low to be significant.

Summary

The present chapter has been devoted to the investigation of differences in school and home environments as perceived by HSC and LSC children. Significance of these differences was tested with the help of Kolmogorov-Smirnov Two-Sample test. Ogives of boys/girls with HSC or LSC were also drawn to probe deeper into the observed phenomena.

It was found that HSC children do not differ significantly from LSC children in their perception of creative stimulation, cognitive encouragement, acceptance, permissiveness, control andrejection in school environment. They perceived same amounts of overall stimulation in school environment as well as home environment They perceived same amounts of control, protectiveness, conformity, punishment, deprivation of privileges, reward, rejection and permissiveness in their home environment. HSC boys perceived less social isolation than LSC boys while girls belonging to the two groups perceived same amounts of it. As compared to LSC girls, HSC girls perceived more nurturance in home environment. Boys of both of the groups perceived same amounts of nurturance.

Some interesting facts were brought to light by the study of ogives of HSC and LSC boys and girls. Both HSC and LSC girls perceived inconsistency in teachers' behaviour to—(i) stimulate children's cognitive development by encouraging their actions or behaviours, (ii) provide opportunities to them for free expression of views and uninterrupted activities, (iii) recognize their right to express feelings, to uniqueness and to be autonomous individuals, and (iv) impose restrictions on students to discipline them. Boys' perception of control and rejection in school environment , and control, conformity, protectiveness, reward and nurturance in home environment revealed inconsistencies in teachers' and parents' behaviours. Girls' perception of reward and deprivation of privileges reveals inconsistencies. As compared to HSC boys, LSC boys perceived consistently more cognitive encouragement (more difference at Q_1 and median) and more permissiveness (more difference at Q_3) in their school environment. HSC girls perceived consistently more

creative stimulation in schools and less control and rejection in home environment than LSC boys Except at extremes the HSC boys as well as girls perceived consistently less punishment and more permissiveness in home environment than their LSC counterparts HSC boys perceived less deprivation of privileges (difference more at median) and less acceptance than LSC boys while HSC girls perceived more protectiveness, more rejection, less social isolation (more difference at Q_1) and more nurturance (difference more at Q_1, median and Q_3) than LSC girls. HSC boys perceived less social isolation than LSC boys (difference more at Q_3 and median). On the whole study of ogives revealed the same findings as were discovered earlier when Kolmogorov-Smirnov Two-Sample Test was used.

Development of Scientific Creativity Epilogue :

Usually people think that the whole cultural fabric of India, by and large, is not conducive to the release of the creative impulse. T. N. Raina (1973) aptly remarked .

> "The doctrine of *Karma* with its fatalism, the theory of transmigration with its predetermination, the theory of *varnas* with its ruthless casteism and the doctrine of male authoritarianism are all, what Torrance (1962) would call 'cultural blocks to creativity'. Inside the educational institutions and outside, one finds authoritarianism and dogmatism—a crusty rigidity and stubborn submission to the embalmed and venerated, monolithic *status quo* Rules and regulations are sanctimonious, they have been rendered all the more sanctimonious by the countless generations that practised them down the ages and cannot consequently be teargressed or broken."

Under these conditions of conventions and reputable standards, the effect on creative minds is one of oppression and frustration. Individuals will conform to group norms and will not be liberated from the cataract of accepted beliefs (Koestler, 1959) and ideals in the field of science in particular and others in general. Their cabined and cribbed creative minds will not have the delights of independent scientific thinking. The creative ones will have the pressing need "to find somebody to whom they can surrender as quickly as possible that gift of freedom which they, the unfortunate creative ones, were born with (Dostoyevsky, 1950) Ours is a democratic country and we, the citizens, cannot allow parents or teachers to stifle creativity among the creative persons, specially among those who are studying science. These and other similar views inspired the researcher to undertake this investigation. In the previous chapters the data were analysed and interpreted In the proceeding pages an effort has been made

to present various findings of this study in a coherent manner and to identify the educational implications of these findings

11. 1. Findings

(A) Sex differences in scientific creativity

Boys do not differ significantly from girls with respect to inquisitiveness which is an aspect of scientific creativity. However, girls excel boys in overall scientific creativity and in three aspects of it, *viz.* fluency flexibility and originality.

(B) Differences in home/school environments as perceived by children with high or low scientific creativity

(1) When 'Kolmogorov-Smirnov two sample test' was used to test the significance of differences in HSC* and LSC** children's perception of their home and school environments, it was found that—

(i) HSC girls do not differ from LSC girls in their perception of eight aspects of home environment (*i.e.* control, protectiveness, punishment, deprivation of privileges, rejection, permissiveness, social isolation, and reward) and overall school environment as well as various aspects of it *i.e.* creative stimulation, cognitive encouragement, acceptance, permissiveness, rejection, and control).

(ii) HSC boys do not differ significantly from the LSC boys in their perception of overall stimulation in home environment as well as nine aspects of it, namely control, protectiveness, punishment, conformity, reward, deprivation of privileges, nurturance, rejection and permissiveness. They do not differ from each other with respect to their perception of overall stimulation in school environment and six aspects of it

(iii) As compared to LSC boys, HSC boys perceive less social isolation in their home environment.

(iv) As compared to LSC girls, HSC girls perceive more stimulation in their home environment (total perspective) and more nurturance in their homes.

(2) A gestalt view of the ogives of HSC and LSC children's perception of home/school environment lends support to the above men-

---

* With High Scientific Creativity

** With Low Scientific Creativity

tioned findings. It is interesting to note that as compared to the median values for LSC girls, more than 50 per cent of the HSC girls perceived more stimulation in their home (total perspective and various aspects of it). In case of boys, the same phenomenon appeared with respect to their perceptions of overall stimulation in home environment and seven aspects of it, namely-reward, punishment, social isolation, deprivation of privileges, rejection, nurturance and permissiveness. Similar phenomenon was observed in case of HSC girls' perception of overall stimulation in school environment (*i e.* total perspective) and four aspects of it, *viz* creative stimulation, permissiveness, acceptance and rejection In case of boys this was evident with respect to HSC boys' perception of creative stimulation, control and rejection.

Both the HSC and the LSC girls perceived inconsistency in teachers' behaviours pertaining to cognitive encouragement, permissiveness, acceptance and control ; and in parents' behaviours to use reward or deprivation of privileges Boys perceived inconsistencies in teacher-pupil-interaction with respect to control and rejection ; and in parental childrearing behaviours pertaining to control, conformity, protectiveness, reward, and nurturance. As compared to HSC boys LSC boys perceived consistently more cognitive encouragement, and more permissiveness in their school environment. The HSC boys perceived consistently more creative stimulation in school environment and less rejection in home environment than the LSC boys HSC girls perceived consistently more creative stimulation in schools and less control and rejection in home environment than the LSC girls HSC girls perceived more protectiveness, less rejection, less social isolation and more nurturance in homes than LSC girls. HSC boys perceived less deprivation of privileges, less social isolation and less acceptance than the LSC boys.

(C) Relationship between perceived home/school environment and scientific creativity

Significant relationships have been found to exist between (1) perceived school environment and originality among boys, (2) perceived home environment and scientific creativity (overall, and fluency and originality aspects of it) among girls , (3) perceived home environment and inquisitivenes aspect of scientific creativity among boys. All of these five significant relationships between environmental variables and dependent variables seemed to be tied with verbal intelligence, nonverbal intelligence and socio-economic status Besides this, the relationship between inquisitiveness and home environment is tied with neuroticism (in case of boys) However,

the relationships between perceived home environment and originality/fluency/overall scientific creativity among girls was found to be tied with extraversion

(D) Relationship between various aspects of perceived school environments and scientific creativity

Sixty Spearman coefficients of correlation were computed to study the relationship between various aspects of perceived school environment and scientific creativity among boys and girls In all only six correlations were found to be significant at .05 level. These correlations indicate existence of significant negative relationship between—

(i) creative stimulation and flexibility among boys,

(ii) creative stimulation and originality among boys,

(iii) cognitive encouragement and overall scientific creativity as well as originality and inquisitiveness aspects of it, and

(iv) permissiveness and originality among boys.

(E) Relationship between various aspects of perceived home environment and scientific creativity

Out of the 100 rank coefficients of correlation between aspects of perceived home environment and scientific creativity (overall as well as fluency, flexibility, originality and inquisitiveness aspects of it), 12 correlations were positive and significant at 05 level. These significant correlations indicate existence of positive relationship between (1) decreasing amounts of protectiveness as perceived by girls and their inquisitiveness , (2)decreasing amounts of deprivation of privileges as perceived by boys and their originality , (3) decreasing amounts of rejection as perceived by girls and their fluency as well as inquisitiveness , (4) increasing amounts of nurturance as perceived by girls and overall scientific creativity as well as fluency, flexibility and originality aspects of it , (5) boys' perception of increasing amounts of nurturance and their inquisitiveness; and (6) boys' perception of permissiveness and their overall scientific creativity and originality and inquisitiveness aspects of it. Besides the twelve positive correlations (significant at 05 level), two negative correlations were significant at 05 level. They indicate that decreasing amounts of protectiveness and conformity are negatively related with boys' inquisitiveness

(F) Effect of different levels of stimulation in home environment on the scientific creativity of children perceiving same or different levels of stimulation in school environment

Scientific creativity scores in general and scores on fluency, flexibility, originality and inquisitiveness in particular among boys perceiving high/normal/low stimulation in school environment do not vary with the level of stimulation perceived in home environment Fluency, flexibility and inquisitiveness scores of girls perceiving normal stimulation in school environment do not vary with the level of stimulation perceived in home environment. However, as compared to girls perceiving low stimulation in homes but normal stimulation in school environment, girls perceiving high stimulation in home environment and normal stimulation in shool environment obtain higher scores on overall scientific creativity and originality aspect of it Girls perceiving high/normal/low levels of stimulation in home environment but either high or low stimulation in school environment do not differ from each other with respect to their overall scientific creativity and originality aspect of it Thus, as compared to low level stimulation in home environment, high level stimulation in home environment may be more conducive to the development of scientific creativity among girls.

11 2. Inference

The present study has revealed that girls excel boys in overall scientific creativity and fluency, flexibility and originality aspects of it (as measured by our tests of scientific creativity). Similar findings have been reported by Yamamoto (1960), Torrance (1962), Neufeld (1964), Razik (1964), Dauw (1966), Littlejohn (1967), MacGregor & Smith (1967), Harlow (1967), Solomon (1968), Ogletree (1968), Fletcher (1968), Bowers (1971), Dhir (1973), Goyal (1973) and Hussain & Hussain (1975) with respect to general creativity. These differences may be attributed to genetic and experiential factors Determination of the effects of genes on development of scientific creativity was beyond the scope of the investigation. We have studied the effects of perceived home and school environments (as measured by our tools, *viz*. Home Environment Inventory and School Environment Inventory, on the scientific creativity among boys and girls.

We have found that both the HSC and the LSC children (boys as well as girls) perceive nearly the same amounts (*i.e* not significantly different) of 'Creative Stimulation', 'Cognitive Encouragement', 'Acceptance', 'Permissiveness', 'Rejection', and 'Control' in their school environment. This indicates that our teachers do not try to provide a more congenial climate for HSC children. They seem to have faith in equalisation of psychological and ecological facilities for all the students in their classrooms This implies that these factors may be conducive to the

development of scientific creativity among children. Following views of Vinacke (1952) warn us to postpone the process of decision making

1. Creativity calls upon free reorganisation of past experiences and is influenced more by inner-need states than by external demands It is under great voluntary control

2 Certain conditons confront every individual, *i e* are universal in all cultures Some are idiosyncratic, having an effect only on a few persons or a single individual.

Inspite of similarities in various aspects of school environment as perceived by HSC and LSC children, our research has disclosed the existence of significant relationships between—(1) 'Creative Stimulation' and 'Flexibility' for boys, (2) 'Cognitive Encouragement' and 'Originality' for boys, (3) 'Creative Stimulation' and 'Originality' for boys, (4) 'Cognitive Encouragement' and 'Inquisitiveness' for boys, (5) 'Cognitive Encouragement' and 'Scientific Creativity' for boys, (6) 'Permissiveness' and 'Originality' for boys These relationships indicate that 'Creative Stimulation', 'Cognitive Encouragement' and 'Permissiveness may affect the development of scientific creativity to some extent irrespective of their perceptions of similar stimulation in school environments It indicates that 'Creative Stimulation', 'Cognitive Encouragement' and 'Permissiveness' aspects of school environment have idiosyncratic effects It is surprising to note that boys' perception of less quantities of creative stimulation, cognitive encouragement may promote the development of scientific creativity among them Such a situation does not exist in case of girls. Thus, it appears as if our girls had been immune to the effects of teacher-pupil interaction. It is quite embarrassing to note that boys' perception of more 'Creative Stimulation', 'Cognitive Encouragement' and 'Permissiveness' may inhibit the development of scientific creativity among boys However, our observations lend support to our inference All of us may agree that most of our schools (none of the schools selected for carrying out the present investigation) do not provide specific cognitive programmes for encouraging scientific creativity So, if we only provide a very stimulating climate, boys who had to be more sincere in their academic and scientific pursuits, will get bored and this may result in production of less creative ideas through the media of science and exercise of less creative thinking while learning science. In view of such perceptions our HSC subjects may get annoyed with teachers' practices of providing same amounts of 'Creative Stimulation', 'Cognitive Encouragement' and 'Permissiveness' to HSC as well as LSC children. It is worth stressing that these aspects of school

environment may not be too powerful to seriously impair the process of development of scientific creativity among boys The reason for laying such a stress is that relationships between the dependent and the independent variables are very low

The present study has revealed that both the HSC and the LSC boys as well as girls perceive nearly the same amounts of 'Control', 'Protectiveness', 'Punishment', 'Reward', 'Rejection', 'Deprivation of Privileges', and Permissiveness' in their home environment However, we have found significant relationship between (1) 'Protectiveness'* and 'Inquisitiveness' (for boy and girls), (2) 'Rejection'* and 'Inquisitiveness' (for girls); (3) 'Permissiveness'** and 'Inquisitiveness' (for boys), (4) 'Deprivation of Privileges'* and 'Originality' (for boys) ; (5) 'Permissiveness'** and 'Originality' (for boys) These relationships once again reflect the idiosyncratic effects of 'Protectiveness' and 'Rejection' aspects of home environment for HSC and LSC girls and 'Permissiveness', 'Protectiveness' and 'Deprivation of Privileges' for boys Interaction between the personality structure of HSC children and their perceptions of 'Protectiveness', 'Permissiveness' 'Deprivation of Privileges' and 'Rejection' aspects of home environment may be responsible for the idiosyncratic effects of these aspects of home environment.

Our study has shown that as compared to LSC girls, HSC girls perceive more nurturance in home environment Girls' perception of increasing amounts of nurturance in home environment has been found to be positively correlated with 'Overall Scientific Creativity', 'Fluency' 'Flexibility', and 'Originality' variables. In case of boys inquisitiveness was found to have a positive and significant relationship with 'Nurturance' but the HSC boys did not differ from the LSC boys in their perception of nurturance in home environment This latter finding reflects the idiosyncratic effects of 'Nurturance' in home environment

As compared to LSC boys, HSC boys perceived less social isolation in home environment This aspect of home environment has been found to be insignificantly related with scientific creativity in case of boys Thus, it reflects the ineffectiveness of children's perception of decreased amounts of 'Social Isolation' in the development of scientific creativity Similar inefficiency has been reported for girls too but they did not perceive significantly different amounts of 'Social Isolation' in home environment.

*indicates decreasing amounts

**indicates increasing amounts

To sum up, we can say that HSC girls' perception of more nurturance than that of LSC girls may be conducive to the development of scientific creativity Girls' perception of decreasing amounts of 'Rejection' and 'Protectiveness' in home environment and boys' perception of decreasing amounts 'Deprivation of Privilege's, 'Protectiveness' and increasing amounts of 'Permissiveness' & 'Nurturance' may contribute to the development of of scientific creativity It does not matter much whether they perceive as much nurturance, protectiveness and deprivation of privileges as is perceived by LSC boys in their home environment Schools have failed to generate special climates for the HSC children so as to develop their scientific creativity. It can be believed that most of our schools stress equalization of educational opportunities for all the students The HSC children are usually neglected in our schools To us, it is not surprising to note that the HSC and the LSC children perceive same amounts of 'Cognitive Encouragement', 'Rejection', 'Control' and 'Acceptance' in school environment It is inherent in human nature to crave for social recognition No one wishes to be ignored. The HSC children, too, are human beings and therefore, the feelings of being neglected may be more injurious in curbing students' scientific creativity (more in case of children who exhibit less creativity through the media of science and possess less motivation to pursue work demanding scientific creativity) Girls' scientific creativity may not be influenced by their school environments but increasing stimulation in school environment may inhibit the development of scientific creativity among boys

Now one question strikes our mind We have found that girls excel boys in overall scientific creativity and fluency, flexibility, and originality aspect of it If environment is to influence the development of scientific creativity in a similar fashion, boys must have been more creative (in science) because more aspects of home and school environment seem to influence the development of scientific creativity among boys than among girls It is quite amazing to note that girls' scientific creativity appears to be influenced by decreasing amounts of rejection and increasing amounts of nurturance in home environment while boys' scientific creativity seems to be influenced by increasing amounts of 'Protectiveness', 'Conformity' and 'Nurturance' , and decreasing amounts of 'Deprivation of Privileges' in home environment and decreasing amounts of 'Creative Stimulation', 'Cognitive Encouragement' and 'Permissiveness' in school environment It is quite interesting to note that 'Nurturance' in home environment promotes the development of scientific creativity among boys as well as girls

Is rejection more powerful ? Is school environment less powerful than home environment ? Which personality characteristics interact with girls' perception of rejection and nurturance in home environment to make it a powerful factor contributing to the development of scientific creativity among girls ? These questions still remain unanswered. To the researcher it seems as if girls' greater sensitivity to and strivings for avoidance of rejection, as used by parents and more nurturance, as provided by parents had produced greater impact on their scientific creativity. Thus, home environment is more powerful than the school environment. This conclusion draws support from our finding that as compared to low stimulation in home environment, greater stimulation in home environment is more conducive to development of scientific creativity (overall) and originality aspect of it among girls perceiving same (*i.e.* normal level) stimulation in school environment These differences have not been found in case of boys This reflects the greater sensitivity of girls, who perceive normal level stimulation in school environment but high or low level of stimulation in home environment

Our research findings indicate that both the HSC and LSC boys as well as girls perceive similar amounts of overall stimulation in school environment. However, this overall stimulation in school environment has been found to be negatively related with originality, an aspect of scientific creativity among boys'. This clearly reflects the idiosyncratic effects of overall stimulation in school environment as perceived by children. Boys' scientific creativity seems to be more influenced by their perception of decreasing amounts of stimulation in school environment. Similar idiosyncratic effects have been reported in case of boys' perception of overall stimulation in home environment because increasing amounts of stimulation in home environment have been found to be positively related with inquisitiveness aspect of scientific creativity though the HSC and the LSC boys did not differ in their perceptions of stimulation in school environment HSC girls perceive more stimulation in their home environment than the LSC girls, and girls' overall scientific creativity as well as fluency and originality aspects of it have been found to be significantly and positively correlated with the overall stimulation as perceived by girls in their home environment This implies that increasing stimulation in home environment may be more conducive to the development of scientific creativity The relationships between (1) perceived home environment and overall scientific creativity or fluency & originality aspects of it (among girls) , (2) inquisitiveness and home environment as perceived by boys ; and originality & school environment as perceived by boys, are tied with verbal intelligence, nonverbal intelligence and socio-economic status.

Relationships for boys are tied with neuroticism while those for girls are tied with extraversion also. The exact role of these factors is yet to be investigated

To sum up the above discussion, we can say that—

(1) There are some environmental conditions which are perceived in similar degrees by all children. Some of them may influence the development of scientific creativity. These environmental factors which have idiosyncratic effects on the development of scientific creativity are (1) protectiveness (decreased amounts), (2) rejection (decreased amounts) and (3) overall stimulation in home environment (increased amounts) as perceived by girls and decreased amounts of creative stimulation, cognitive encouragement, and permissiveness aspects of school environment as perceived by boys Boys' perception of decreased amounts of deprivation of privileges, and protectiveness and increased amounts of nurturance and protectiveness in their home environment, too, have idiosyncratic effects on the development of scientific creativity among boys

(2) Increasing amounts of nurturance and overall stimulation in home environment as perceived by girls may contribute significantly to the development of scientific creativity among girls.

(3) High stimulation in home environment is more conducive to the development of scientific creativity among girls perceiving normal level stimulation in their school environment.

These general conclusions draw additional support from the comments of Evans & McCandless (1979) and Torrance & Torrance (1976). The former think, "Most of us who have children or who have worked with children have observed them react differently to uniform treatment" The latter surveyed 140 experiments which were designed to influence creativity among school-age children and youth They concluded, " the ability to perform creativcly or better to exercise divergent thinking, can be influenced to some extent by environmental manipulations feasible in the classroom. Not all children and youth show gains, nor is the gain always impressive But change can occur. The more disciplined or organized and systematic strategies are the most effective "

Thus, home environment stimulation influences the development of scientific creativity among boys as well as girls while stimulation in school environment is effective in case of boys only Boys' perception of

decreasing levels of stimulation in school environment specially in respect of creative stimulation, cognitive encouragement, permissiveness and acceptance may contribute significantly to the development of their scientific creativity Increasing levels of nurturance and decreasing levels of protectiveness as perceived in home environment promote the development of scientific creativity among boys and girls In addition to this boys' scientific creativity may be inhibited by less conformity and permissiveness and more deprivation of privileges. In case of girls, decreasing levels of rejection, if perceived so by them, may promote the development of their scientific creativity.

11.3 Delimitations of the Study

Following have been the delimitations of this study—

1. Test-retest reliability and criterion related validity of 'Home Environment Inventory' and 'School Environment Inventory' has not been determined

2. It was initially planned to conduct this study on a sample of 300 students. However, the unwillingness of a few institutions to provide adequate facilities for collection of complete relevant data has forced the researcher to limit the sample size and be contented with the data about 197 students only.

3. Though it was planned to study the best combination of home and school environment characteristics, verbal and non verbal intelligence, neuroticism and extraversion, and socio-economic status which contributes to the prediction of scientific creativity, the researcher could not achieve this objective because the distributions of the scientific creativity scores of boys as well girls were skewed.

4. Only those students who were studying Biology, Physics, and Chemistry science subjects in their XI & XII classes were selected for this study This was done because our tests of scientific creativity are more suitable for such students.

5. Because of the smaller size of the sample, we have not tried to probe deeper into the relationship of various environmental variables with the overall scientific creativity and various aspects of it, among children differing with respect to intelligence, extraversion and socio-economic status.

6. As per expert opinion we have constructed inventories to measure 6 aspects of school environment (creative stimulation,

cognitive encouragement, control, rejection, acceptance and permissiveness) and ten aspects of home environment (i.e. control, reward, punishment, conformity, social isolation, rejection, nurturance, permissiveness, deprivation of privileges, and protectiveness).

11 4 Significance of the Study

Scientific creativity is a potential ability and a potential ability means an ability which can be fully developed, if and only if certain conditions are fulfilled. If the home and the school environments of the apparently creative science students did not fulfil these necessary conditions, this potentiality would not be able to develop fully

11.4 1 *Significance for Teachers*

The work of Vygotsky (1934) provides a social—historical perspective for learning environment relationships. He maintained that thinking processes change in a manner that is complete, dynamic and interrelated with environmental phenomena He observed that the level of thinking of an individual, whether elementary or higher, reflects his particular environment and significant changes in that environment can be expected to change the thinking patterns of the individual We have to keep in mind Hildebrand's (1976) words, "If a teacher loses faith in the child's creative ability or falls victim to pressures to produce products, she will hurt the child and his future creativity. Henceforth, the child will wait for her idea, her correct way before beginning. The child won't enjoy his products or the process." Like Lowenfeld and Brittain (1970) we think that in a well balanced educational system, in which the development of the total being is stressed, each individual's thinking, feeling and perceiving must be equally developed in order that his creative abilities can unfold.

Scientific creativity can safely be compared to human embryo's essence of life If the human embryo soon after the conception is not identified and left to itself to develop, it must and is bound to perish as a result of his or her failure to get over adverse circumstances But if a congenial environment is provided it will hatch and develop The time demands that we must seriously think over our practices in the classroom. We do not want that scientifically creative students be compelled to choose the paths of delinquency, mental illness, a life of mediocrity and unrealized potentiality To prevent this, serious attempts to identify scientific creativity is the nascent need and the 'Tests of Scientific Creativity' developed by the author can help teachers to identify the talented students Mere identi-

fication of this valued potentiality will not help us to justify our importance Our science teachers in particular and other teachers in general will have to provide that kind of educational climate and psycho-social environment which will facilitate the development of scientific creativity. The findings of the present investigation will help teachers to study the development of scientific creativity among students and evaluate the school environment in which they study to check whether the scientifically creative students perceive their environment as congenial or not.

It is to be remembered that some students suffer from the adverse conditions that pervade their home environment. All that can be done for them is to try and improve their conditions in future and try to compensate for the deficiencies of the past in their present schools. Present study has led to the identification of home environmental characteristics which are conducive to the development of scientific creativity and therefore, through parent teacher associations, teachers can try to convince parents to improve adverse home environmental conditions. They will also be able to make up for the deficiencies of home in the school

11 4.2. *Significance for Educational Administrators*

One cannot produce creativity, only nurture it (Gibb, 1968). This observation is also valid in case of scientific creativity and in this respect our institutions have to take steps to ensure that scientifically creative minds continually rise to the top of the organization Otherwise, organizations will show the effects of the time in the form of aging and in the form of diminishing total effective creative power Consequently, they grow old and die as many corporations and organizations do each year. An organizational programme that will optimise scientific creativity is a nascent need and with the help of the findings of this study, such an organisational structure and a psycho-social environment can be established in our institutions as may be the most ideal for the development of scientific creativity. Findings of this study demand that principals must try to improve the creativeness of the school environment by hoisting umbrellas as buffers against outside forces including forces from other parts of the system. Under these umbrellas they may be able to provide climates, largely of their own making, in which staff and students will function better than in those already established

The study has revealed certain psycho-social characteristics of home environment under which creative thinking through the media of science flourishes best These factors are decreased amount of protectiveness,

conformity, deprivation of privileges, rejection, and increased amounts of nurturance and permissiveness. Our administrators may be able to create these environments in hostels of residential schools.

With the help of the findings of this study our schools may be able to act according to Ruth Strang's advice i e. to know the child's home environmental factors conducive to scientific creativity, recognize the good features of parent's behaviours and practices and build on this foundation They must not lay too much emphasis on greater stimulation in schools because this may inhibit the development of scientific creativity

11.4 3. *Significance for Creative Students and Counsellors*

Every individual has within himself an inner urge toward self-realization, self-expression, self-direction and positive health Counsellor helps him in the liberation of these urges. After having identified highly creative science students, the counsellor, through group procedures of guidance, can explain to them that more stimulation in the home environment and normal stimulation in school environment will lead to the best development of their scientific creativity. Findings of the present study may assist him in using adaptation techniques so as to preserve his or her scientific creativity

Then, with the knowledge of such environmental characteristics which are conducive to creativity, students will be able to guard themselves and they may not become victims of those practices of parents or teachers which are likely to stifle their creative potential. So, students may learn to preserve their creative talent even when more protectiveness, conformity, rejection and deprivation of privileges exist in their home environments, less nurturance or permissiveness pervade their home ; and very high level creative stimulation , cognitive encouragement and permissiveness exist in their school environment

11 4 4 *Significance for Parents*

Home-school understanding and cooperation are generally accepted as basic to smooth continuity of growth as the child moves from home into the new and different environment of school. This is important not only as he enters kindergarten (or nursery school) but also as he moves back and forth between home and school throughout his formal educational experience (Breckenridge & Vincent, 1966) Parental attitude toward the school may sabotage anything the school might try to do for the child. Unfortunately, the prevailing attitude of many parents in our country today

is to "send Lalla or Munna to school and then wash their hands of any responsibility for his education". Rejai (1979) has very beautifully enumerated the failure of parents in the educative process . " . it is the parental abdication of responsibility to help educate their children that lies at the core of the many problems the educational process faces today. Until such time as the parents give up the easy way out and resume responsibility to cultivate in their children the active habits of reading, writing, speaking and thinking, we can expect the situation to deteriorate." More painful has been the fact that in recent years parents have sued schools and colleges for "educational malpractice" i e. failure to educate their children.

The findings of this study reveal that the climate of the home is more important than that of the school. It is quite possible to see students coming from homes that are so much drab and lifeless that the child is little better off than the laboratory mouse confined to his cage. Not only in the home but throughout society, adults manipulate the environment in all sorts of ways that modify children's perceptions. Rogers (1969) observes, "In general, a conformist upbringing snuffs out the twin candles of curiosity and creativity that burn in young children " Although research data do not support the contention that a child develops a specific ability because his parents have selectively trained him in it, the manner of childrearing and the quality of parent-child relationships have been found to limit the intervening conditions that stimulate or suppress differential abilities (Bing, 1963).

The findings of this investigation will help parents in deciding what type of environment should be created by them in their homes so that their children may be able to develop their scientific creativity to the maximum limit They will be able to realize that the interests of the home and the school overlap and intermingle Findings of this study can enable parents to act according to Gamble's advice of carrying more of the school into the home so as improve home conditions and thereby contribute more to the development of scientific creativity

11.5. Suggestions for Further Study

This study was conducted on a small sample Hence, results of this study may be further verified by studies to be conducted on large samples. The relationships between environmental factors and scientific creativity do not reveal the impact of different environmental characteristics on the development of scientific creativity among children possessing different personality characteristics

It is quite possible that children with different levels of scientific creativity, and cognitive and affective traits of personality may be influenced by their perceptions of stimulations in home/school environments in different ways. This may be explored by further researchers It will be desirable to find out how the satisfaction of different individuals with the stimulations they perceive in their environments influences the growth of their scientific creativity

The adaptation techniques that are adopted by children for coping with the environmental pressures may influence the development of their scientific creativity So, studies may be undertaken to study the role of perceived environments on the development of scientific creativity among students using different adaptation techniques, (viz compliance, counter aggressiveness, indomitable persistence, clowning, silence, apparent ignoring of criticism, apathy, inconsistent performance, filling the gap when others falter, solitary activity, etc

Our discussions of findings indicated that monotonous stimulation in classroom may not be as much conducive to the development of scientific creativity as the specific cognitive programmes designed to act as catalyst for the development of scientific creativity Such programmes can be developed and then experimental studies may be undertaken to find out the extent to which the development of scientific creativity is influenced by monotonous stimulation and cognitive programmes when launched in a stimulating climate The problems faced by students in their family and their classrooms may be found out and their role in the development of scientific creativity may be ascertained

The inferences drawn from the findings of this study indicate that levels of behavioural consistency among teachers' and parents' actions to provide stimulating conditions influence the development of scientific creativity This inference is yet to be probed further.

Besides these, the role of ecological environments of home and school, the personality of teachers and parents, quality of instruction, structure of the home and cultural norms that are conventionally accepted in a family, may have some impact on the development of scientific creativity among children Children's affiliations, peer-group preferences for certain activities and devices used by the members of the peer-group to control the behaviour of other group members are yet to be studied as determinants of scientific creativity Researchers can investigate the role of environments in the development of scientific creativity of children belonging to different

cultural groups. Thus, school, home, peer group, community and the child with his or her unique characteristics may influence the development of scientific creativity among children This discussion can be summed up symbolically as presented in the model in figure 1 given below :

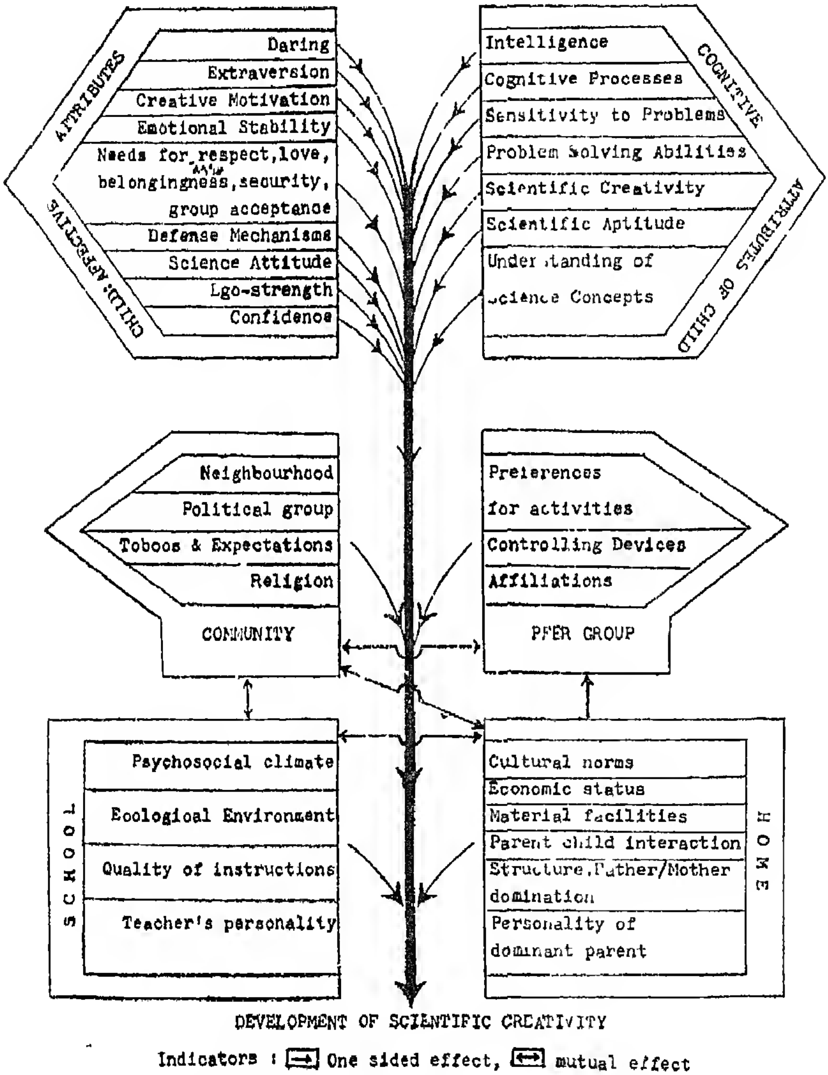

FIG. 1 MODEL FOR STUDY OF FACTORS RELATED TO SCIENTIFIC CREATIVITY

* * * * *

BIBLIOGRAPHY

Abraham, E C The selected creativity tasks. *Journal of Creative Behavior*, 1977, 11(3), 205.

Ackerman, N W. *The psychodynamics of family life* New York Basic Books, 1958.

Agarwal, S. and Kumari, S. A correlational study of risk taking and creativity with special reference to sex differences *Indian Educational Review*, 1982, 17 (3), 104-110

Aggarwal, V P and Verma, L P Internal-external control or high creative and low creative high school students at different levels of socio-economic status. *Journal of Creative Behavior*, 1977, 11 (2), 150

Ahmed, S Interactional effect of the home and school disadvantage on intellectual ability *Psychologia . An International Journal of Psycology in the Orient*, 1982, 25 (1), 65-69. In *Psychological Abstracts*, 1983, 69 (1), 2000-2001

Aldous, J. The search for alternatives · parental behaviours and children's original problem solutions. *Journal of Marriage and Family*, 1975, 37 (4), 711-722. In *Psychological Abstracts*, 1976, 56 (4), 715 (5985)

Amidon, E J. and Flanders, N.A. The role of the teacher in the classroom · A manual for understanding and improving teachers' classroom behaviour Minneapolis · Amidon & Associates.

Amidon, E. J. and Flanders, N.A The effects of direct and indirect teacher influence on dependent prone students learning geometry. *Journal of Educational Psychology*, 1961, 52, 286-291

Anderson, G. J. Effects of classroom social climate on individual learning. *American Educational Research Journal*, 1970, 7 (2), 135-152

Anderson, G. J Effect of course content and techer sex on the social climate of learning *American Educational Research Journal*, 1971, 8, 649-663.

Anderson, H H and Anderson, G. L A cross-national study of children · A study in creativity and mental health. In Gordon, I. J. (Ed.) *Human development . Readings in research* Glenview, Ill. . Scott, Foresman, 1965.

Anderson, G. J , , Walberg, H. J. and Welch, W. W. Curriculum effects on the social climate of learning A new representation of discriminant functions. *American Educational Research Journal*, 1969, 6, 315-328

Anderson, R. D ; Devito, A. ; Dyrli, O. E ; Kellogg, M. , and Weigand, J. *Developing children's thinking through science* New Jersey, Englewood Cliffs Prentice Hall, 1970, 92

Angenent, H L. The basis for child rearing as determined by a questionnaire. Gedrag *Tijdschrift Voor Psychologie*, 1976, 4 (1), 39-50 In *Psychological Abstracts*, 1976, 56 (5), 934, (7787)

Annes, A , Jr. Visual perception and the rotating trapezoidal window. *Psychological Monographs*, 1951, 65, No 324.

Aponte, H S The family school interview an eco-structural approach *Family Process*, 1976, 15 (3), 303-309-

Armentrout, J. A Repression—sensitization and MMPI correlates of retrospective reports of parental child rearing behaviors. *Journal of Clinical Psychology*, 1975, 31(3), 444-448 In *Psychological Abstracts*, 1976, 56 (5), 843 (7024).

Atkinson, J. W *Motives in fantasy, action and society* New York Van Nostrand, 1958, 40.

Bahn, C. The interaction of creativity and school facilitation in creative problem solving Doctoral dissertaion, Columbia University, 1964

Baldwin, A.L The effect of home environment on nursery school behaviour *Child Development*, 1949, 20, 49-62

Baldwin, A. L ; Kalhorn, J and Breese, F H. Patterns of parent behaviour. *Psychological Monograph*, 1958, 3 (1), 73

Balka, D S The development of an instrument to measure creative ability in mathematics Ph D Dissertation, University of Missouri, 1974

Barchillon, J Creativity and its inhibition in child prodigies personality dimensions of creativity N Y Lincoln Institute of Psychotherapy, 1961. In Torrance, E. P *Rewarding creative talent . Experiments in classroom creativity* New Jersey, E Cliffs Prentice Hall, 1965

Barker Lunn, J C *Streaming in the primary schools Research report* London National Foundation for Educational Research 1970

Barron, The psychology of imagination *Scientific American*, 1958, 199 160-162

Barron, F *Creative person and creative process* New York : Holt, Rinehart and Winston, 1965

Barth, R S. Open education and the American school NYC Agathon Press, 1972

Beach, F A. and Jaynes, J. Effects of early experience upon the behavior of animals *Psychological Bulletin*, 1955, 51, 239-263

Beckwith, L. Relationship between attributes of mothers and their infants' IQ scores *Child Development*, 1971, 42, 1083-1097

Bedrosian, A and Jackson, B Intellectual conformity : not the answer *Journal of Higher Education*, 1958, 29, 385. Cited by Traube, A M in Observations on creativity *Educational Forum*, 1962, 27 (1), 62

Belcher, T L Modeling original divergent responses. An initial investigation *Journal of Educational Psychology*, 1975, 67. 351-358.

Bennett, G K., *et al.* Creativity ratings. *Journal of Creative Behavior*, 1969, 31, 41-49.

Bhatnagar, A. B. Construction and standardisation of the treatment environment inventory *Educational Trends*, 1977, 12 (1, 2), 47-56

Bing, E. Effect of child-rearing practices on development of differential cognitive abilities. *Child Development*, 1963, 34, 631-648.

Blitz, B *The open classroom : Making it work.* NYC : Stanford University Press, 1973

Bolen, L. and Torrance, E An experimental study of the influence of locus of control, dyalic interaction and sex on creative thinking Paper presented at the American Educational Research Association, San Francisco, April, 1976

Bowers, K. S. Sex and susceptibility as moderator variables in the relationship of creativity and hypnotic suggestibility. *Journal of Abnormal Psychology*, 1971, 78 (1), 93-100

Bradley, R H and Caldwell, B M The relation of infants' home environments to mental test performance at fifty four months . a follow-up study. *Child Development*, 1976, 47, 1172-1174

Brandwein, P. F. *The gifted student as a future scientist* New York : Harcourt Brace, 1955

Breckenridge, M, E and Vincent, E. L *Child Development* Tokyo : Toppan Company, 1966

Brierley, J K. *Biology and the social crisis.* London . Hainemann, 1967, 94.

Bronfenbrenner, U Socialization and social class through time and space In Maccoby, E. E., Newcomb, T M and Hartley, L. (Eds). *Readings in social psychology.* Methuen, 1958.

Bronfenbrenner, U. Toward a theoretical model for the analysis of parent-child relationships in a social context In Glidewell, J, C. (Ed.), *Parental attitudes and child behaviour.* Springfeld, Ill · Thomas, 1961

Bruner, J. S. The conditions of creativity In Gruber, H. ; Terrell, G. and Wertheimer, M (Eds.) *Contemporary approaches to creative thinking* New Jersey, E. Cliffs . Prentice Hall, 1962.

Burkhart, R C Spontaneous and deliberate ways of learning. Scranton, Penn. · International Textbook Company, 1962.

Buros, O. K. (Ed) *The seventh mental measurement year book.* New Jersey, Highland Park . The Gryphon Press, 1972, I, 143

Burrows, D and Wolf, B. Creativity and the dyslexic child · A classroom view, *Annals of Dyslexia*, 1983, 33, 269-274 In *Psychological Abstracts*, 1984, 71 (3), 844,

Catell, R. B. The personality and motivation of the researcher from measurements of contemporaries and from biography. In Taylor, C W and Borron, F (Eds.) *Scientific Creativity, Its recognition and development* New York : John Wiley & Sons, 1963.

Channon, C E. The effect of regime on divergent thinking scores. *British Journal of Educational Psychology*, 1914, 44, 89—91.

Cogan, M. L The relation of the behaviour of teachers to the productive behaviour of their pupils. Unpublished doctoral dissertation, Harvard University, 1964.

Cohen, S. R The relationship between convergent and divergent thinking in science as revealed in sixth and seventh graders. *Journal of Educational Research*, 1975, 68 (9), 327-330

Cohen, J Patterns of parental help. *Educational Research*, 1979, 21 (3), 186—193.

Coleman, J S , Campbell, E Q. ; Hobson, C J ; McPartland, J ; Mood, A. M ; Weinfeld, F D and York, R. L. *Equality of educational opportunity* Washington, D C · U S. Government Printing Office, 1966.

Couchenour, D. A The influence of mothers' cognitive orientation on preschool children's play, curiosity and creativity Ph D dissertation Ohio State University, 1983. *Dissertation Abstract International*, 1984, 44 (9), 2694 A

Crandall, V ; Katkovsky, W and Preston, A A conceptual formulation for some research on children's achievement development. *Child Development*, 1960, 31, 787 —797.

Crandall, V ; Preston, A and Rabson, A Maternal reactions and the development of independence and achievement behavior in young children. *Child Development*, 1960, 31, 243—251.

Cropley, A J. Creativity and culture. *Educational Trends*, 1973, 8 (1—4), 19—27.

Cross, H J and Kawash, G F., 1968 In Sims, L. S and Paolucce. B. An empirical reexamination of the parent attitude research instrument (PARI). *Journal of Marriage & the Family*, 1975, 37 (4), 724—732. In *Psychological Abstracts*, 1976, 56 (4) 607—608

Dauw, D. C Life experiences, vocational needs and choices of original thinkers and good elaborators. *Dissertation Abstracts*, 1966, 26 (9), 5223.

Dave, R H The identification and measurement of environment process variables that are related to educational achievement Ph. D. thesis, University of Chicago. Cited by Majoribanks, K in 'Environment as threshold variable an examination. *Journal of Educational Research*, 1974, 67 (5), 210 -212.

Davis and Havighurst, 1943. In Cook, L. A and Cook, E. F (Eds) *A sociological approach to education* New York : McGraw Hill Book Company, Inc., 1960, 183.

Davis, A. and Havighurst, R. J Social class and color differences in child-rearing. *American Sociological Review*, 1946, 11, 698—710.

DeHaan, R. F. and Havighurst, R. J. *Educating gifted children.* Chicago : The University of Chicago Press, 1961.

Dellas, M and Gaier, E L Identification of Creativity. *Psychological Bulletin,* 1970, 73, 55—73.

Desai, K, G Comparative factorial structure of Raven's standard progressive Matrices, Cattell's Culture fair scale 3 and Desai-Bhatt Group tests of Intelligence on samples of various subcultures of Gujrat. *Journal of Psychological Researches,* 1980, 24 (1), 8—15.

Deutsch, M Conflicts : Productive and destructive. *Journal of Social Issues,* 1969, 25, 743.

Dewing, K. The reliability and validity of selected tests of creative thinking in a sample of seventh grade west Australian children. *British Journal of Educational Psychology,* 1970, 40 (1), 15 42

Dewing, K. and Taft, R. Some characteristics of the parents of creative twelve year olds. *Journal of Personality,* 1973, 41, 71—75

Dhir, S Performance of high school students on verbal and figural tests of creative thinking. Masters dissertation, Punjabi University, 1973

Dostoyevsky, F. *The brothers Karmazov.* New York : Random House, 1950.

Douglas, J W. B *The home and the school* MacGibbon & Knee, 1964. Cited by Eggleston, S J. in 'The community environment of the school'. In Craft, M (Ed) *Family, Class & Education : A Reader* London : Longman Group Ltd., 1970, 101.

Dreyer, A. S and Wells, M B. Parental values, parental control and creativity in young children. *Journal of Marriage and the Family,* 1966, 28, 83—88.

Dunnettee, M. ; Campbell, J. and Jaastad, K. The effect of group participation on brainstorming effectiveness of two industrial samples. *Journal of Applied Psychology,* 1963, 47, 30—37.

Ebel, R. L. Must all tests be valid. *American Psychologist,* 1961, 640—647.

Edwards, A. L *Experimental design in psychological research.* New Delhi . American Publishing Co., 1971, 104.

Ehman, L. H. A comparison of three sources of classroom data . Teachers, students and systematic observation. Paper presented at the meeting of the American Educational Research Association, Minneapolis, 1970.

Eisner, E W. Research in creativity. *Childhood Education,* 1963, 398, 371.

Elardo, R. ; Bradley, R , and Caldwell, B. M The relation of infants' home environments to mental test performance from six to thirty six months : A longitudinal analysis. *Child Development,* 1975, 46, 71—76,

Ellinger, B D. The home environment and the creative thinking ability of children. Unpublished doctoral dissertation, Ohio State University, Columbus, Ohio, 1964.

Epstein, A. S. and Radin, N. Motivational components related to father behaviour and cognitive functioning in preschoolers *Child. Development*, 1975, 46, 831—839.

Evans, E. D. and McCandless, B. R. *Children and Youth : Psychosocial development.* New York : Holt Rinehart and Winston, 1978, 51.

Faure, E. *et al. Learning to be.* London : Harrap, 1972.

Feldman, D. *Creativity, intelligence and education.* Yale University Centre for the Study of Education. Mimeographed Report, 1973.

Flanders, N. A Personal-social anxiety as a factor in experimental learning situations. *Journal of Educational Research*, 1951, 45, 100-110.

Flanders, N. A. *Analysing teacher behavior.* New York : Addison Wesley, 1970.

Flavell, J. *The developmental psychology of Jean Piaget.* Princeton, N. J : Van Nostrand, 1963.

Fletcher, K. R. Congruence of self and ideal · Self in original and non-original high school seniors. *Dissertation Abstacts*, 1968, 28 (11), 4907A.

Fraser, E. D. *Home environment and the school.* London Press, 1959. City by Nisbet, J. D and Entwistle, N. J in *Educational research methods.* London , University of London Press, 1970, 70-73.

Frazier, A. *Teaching children today : An informal approach.* NYC : Harper & Row, 1976.

Frederickson, N. and Evans, F. Effects of models of creative performance on ability to formulate hypotheses. *Journal of Educational Psychology*, 1974, 66, 67-82.

Freund, J. C and Cardwell, G. F. A multifaceted response to an adolescent's school failure. *Journal of Marriage and Counselling*, 1977, 3 (2), 49-57.

Friedlander, M. A natural science creativity test as a prediction of creative thinking in science *Creative Child & Adult Quarterly*, 1983, 8 (4), 211-215. In *Psychological Abstracts*, 1984, 71 (10), 296.

Fu, V. R. ; Moran, J. D. ; Sawyers, J. K and Milgram, R. M Parental influence on creativity in preschool children. *Journal of Genetic Psychology*, 1983, 143 (2), 289-91. In *Psychological Abstracts*, 1984, 71 (5), 1233.

Fuqua, R ; Bartsch, I. and Phye, B. An investigation of the relationship between cognitive tempo and creativity in preschool-age children. *Child Development*, 1975, 46, 779-782.

Gagneja, S C. A study of creativity in ninth class students in relation to sex, residential background, academic achievement and parental occupation. Master dissertation, Punjabi University, 1972.

Gaines, R. Children's artistic abilities : Fact or Fancy ? *Journal of Genetic Psychology*, 1983, 143 (1), 57-68. In *Psychological Abstracts.* 1984, 71 (2), 385.

Gallagher, J. J. Productive thinking. In Hoffman, M L. & L.W. (Eds) *Review of child development research* New York : Russel Sage Foundation, 1964, 349-391.

Garrett, H. E. *Statistics in psychology and education.* Bombay : Vakils, Feffer and Simons, Pvt. Ltd., 1966, 191, 223-225.

George, M Classroom behaviour of teachers and its relationship with their creativity and self-concept Unpublished Ph. D. thesis, M. S. University of Baroda, 1976

Getzels, J. W and Jackson, P. W. *Creativity and intelligence.* New York : Wiley, 1962.

Getzels, J. W. Creative thinking, problem solving and instruction. In Hilgard, E R. (Ed.) *Theories of learning and instruction.* 63rd Year Book, NSSE, University of Chicago Press, 1964, 240-267.

Getzels, J W. and Csickszentmihalyi, M. creative thinking in art students, An exploratory study. A Cooperative Research Project, No. E008. University of Chicago, 1964, 202.

Ghiselin, B. *The creative process* New American Library, 1952, 293. In Ebel, R L. (Ed) *Encyclopedia of Educational Research.* (4th ed.) Macmillan Co. 1969, 267

Gibb, J. R. Managing for creativity in the organization. In Taylor, C.W. (Ed.) *Climate for creativity* New York : Pergamon Press, 1972, 23-32.

Gibson, H. B. The measurement of parental attitude and their relation to boys' behaviour *British Journal of Educational Psychology*, 1968, 38 (1), 233-239.

Glidewell, J. Group emotionality and productivity Unpublished doctoral dissertation, University of Chicago, 1953. In Johnson, D. W *Educational psychology* New York : E. Cliffs . Prentice Hall, 1972, 269.

Goertzel, V and Goertzel, M *Cradles of eminence* Boston Little Brown, 1962.

Goldberg, J B. Influence of pupils' attitudes on perception of teachers' behaviours and on consequent school work. *Journal of Educational Psychology*, 1968, 59, 1-15.

Golovin, N E The creative person in science In Taylor, C. W. and Barron, F. (Eds) *Scientific creativity Its recognition and development.* New York · John Wiley & Sons, 1963, 15.

Goodale, R A. Methods for encouraging creativity in the classroom *Journal of Creative Behavior*, 1970, 4 (2), 91-102.

Govatana, A. A comparative study of creative thinking in relation to socio-economic status, school climate and classroom behaviour of high school students in Baroda City (India) and Bangkok City (Thailand). Ph. D dissertation Baroda . M. S. University, 1977.

Gowan, J. C. What makes a gifted child creative ? Four theories. In Gowan, J. C., *et al.* (Ed.) *Creativity : Its educational implications.* New York : John Wiley & Sons, 1967, 9-15.

Gowan, J. C *Development of the creative individual.* California, San Diego . Robert R. Knapp 1972, 9-12

Goyal, R P A study of some personality correlates of creativity in secondary school teachers under training Doctoral dissertation, Punjabi University, Patiala, 1973.

Goyal, R. P. Creativity and school climate : An exploratory study. *Journal of Psychological Research*, 1973, 17 (2), 77-80.

Grebow, H. The relationship of some parental variables to achievement and values in college women *Journal of Educational Research*, 1973, 66 (5), 203-209.

Greenacre, P The family romance of the artist. *Psychoanalytic study of the child*, 1958, 13, 9-43 In Arasteh, A R and Arasteh, J D. (Eds.) *Creativity in human development.* New York : John Wiley, 1976

Guilford, J. P Intellectual resources and their values as seen by scientists. In Taylor, C. W and Barron, F. (Eds) *Scientific creativity . Its recognition and development.* New York John Wiley & Sons, 1963.

Guilford, J. P Some new looks at the nature of creative processes. In Frederiksen, N. and Gulliksen, H (Eds.) *Contributions to mathematical psychology.* New York · Holt, Rinehart and Winston, 1964.

Guilford, J. P. Progress in the discovery of intellectual factors. In Taylor, C. W. (Ed.) *Widening horizons of creativity* New York . Wiley, 1964.

Guilford, J. P Intelligence, creativity and their educational implications. California, San Diego · Robert R. Knapp, 1968, 77-80.

Guilford, J. P. Creativity in interpersonal relationships. In Taylor, C. W (Ed) *Climate for creativity.* New York : Pergamon Press, 1972, 63-74

Guilford, J P. An Information theory of creative thinking. *Educational Trends.* 1973, 8 (1-4), 1-6

Guilford, J P. *Psychometric methods.* New Delhi : Tata McGraw Hill Publishing Co , 1979, 399.

Gupta, A. K Study of pupil creativity in two institutional setttings. *Creativity Newsletter*, 1978, 7 (1), 14-21

Gupta, A K. *A study of classroom teaching behaviour and creativity.* New Delhi · Light and Life Publishers, 1980, 181-257.

Gupta, A. K. and Sharma, S. K. Pupils' creativity in different types of institutional climates : A study. *Journal of Indian Education*, 1981, 6 (5), 27-33.

Haddon, F A. and Lytton, H Teaching approach and the development of divergent thinking abilities in primary schools. *British Journal of Educational Psychology*, 1968, 38, 171-180.

Hall, D T. The effects of teacher student congruence upon student learning in college classes. *Journal of Educational Psychology*, 1970, 61 (3), 205-213.

Harlow, S. D. The development of the originality indicator of creative ability. *Dissertation Abstracts*, 1967, 28 (6), 2094-A.

Harmon, L. R. The development of a criterion of scientific competence. In Taylor, C W. and Barron, F. (Eds) *Scientific creativity · Its recognition and development* New York · John Wiley & Sons, 1963, 44-52.

Hartmann, H. and Kris, E. The genetic approach in psychoanalysis. *Psychoannal Stud. Child*, 1945, 1, 11-30

Hasnain, S Psycho—ecological considerations in creativity. *Creativity Newsletter*, 1978-79, 2 & 1, 24-28.

Havighurst, R. *Developmental tasks and education.* New York · McKay, 1972

Hawkes, G. R The child in the family *Marriage and Family Living*, 1957, 19, 46-51 In Mitchell, J. V Self-family perceptions related to self-acceptance, manifest anxiety and neuroticism. *Journal of Educational Research*, 1963, 56 (5), 236.

Heck, S. F. The creative classroom environment A stage set design. *Journal of Creative Behavior*, 12 (2), 1978, 120-133.

Heilbrin, A B., Jr. Maternal childrearing and creativity in sons. *Journal of Genetic Psychology*, 1971, 119, 175-179

Heist, P College transients. In Heist, P. (Ed.) Education for creativity in the American College. University of California Centre for Research and Development in Higher Education, 1967.

Hildebrand, V. *Introduction to early childhood education.* New York . Macmillan Publishing Co , 1976, 142.

Hilgard, E R Impulsive versus realistic thinking : an examination of the distinction between primary & secondary processes in thought. *Psychological Bulletin*, 1962, 59, 477-488.

Hoffman. L ; Harburg, E. and Maier, N. Differences and disagreement as factor in creative problem-solving. *Journal of Abnormal and Social Psychology*, 1962, 64, 206-214.

Hoffman, M Personality, family structure, social class as antecedents of parental power assertion. *Child Development*, 1963, 34, 869-885.

Horn, J L. and Cattell, R B Refinement and test of the theory of fluid and crystallized general intelligences. *Journal af Educational Psychology*, 1966, 57, 263-270.

Horwitz, R A. Psychological effects of the open classroom. *Review of Educational Research*, 1979, 49 (1), 71-86

Houtz, J. C. and Denmark, R M. student perceptions of cognitive classroom structure and development of creative thinking and problem solving skills *Educational Research Quarterly*, 1983, 8 (3), 20-26 In *Psychological Abstracts*, 1984, 71 (11), 3187

Hudson, L. *Contrary imaginations : A psychological study of the young student* New York , Schocken Books, 1966

Hunt, D E and Sullivan, E V. *Between psychology and education.* Illinois, Hinsdale : Dryden Press, 1974, 84-101.

Hurd, P D. New curriculum perspectives for junior high school science. California, Belmont : Wadsworth Publishing Company, 1970, 30.

Hussain, M. G Creativity and sex differences. *Psychological Studies*, 1969, 19 (2), 27-129

Hussain, M G. and Hussain, Q. Cultural roles, sex difference and creativity. *Educational Trends*, 1975, 10 (2), 141-145

Husaini, B. A Changes in childrearing attitudes of mothers of emotionally disturbed children *Indian Journal of Psychology*, 1975, 50 (3), 232-242.

Inhelder, B. and Piaget, J. The growth of logical thinking from childhood to adolescence. New York · Basic Books, 1958.

Ittelson, W H. ; Rivlin, L. G. : Leanne, G ; Proshanskey, H. M. and Winkel, G H *An introductiou to environmental Psychology.* New York · Holt, Rinehart and Winston, 1974, 113.

Jensen, A. R The culturally disadvantaged : Psychological and educational aspects. *Educational Research*, 1967, 10 (1), 4-20.

Johnson, B L and Kilman, P. R. Relationship between recalled parental attitudes and internal-external control *Journal of Clinical Psychology*, 1975, 31 (1), 40-42, *In Psychological Abstracts*, 1975, 56 (3), 485.

Johnson, R C. Johnson, C. M and Martin, L. Authoritarianism, occupation and sex role differentiation of children. *Child Devélopment*, 1961, 32, 271-276.

Johnson, R C and Medinnus, G. H *Child Psychology* : *Behaviour and development* New York · John Wiley & Sons, 1969.

Jones, T P *Creative learning in perspective* London : University of London Press, 1972, 25

Joshi, M. C. and Tiwari, J Personality development of children in relation to child-rearing practices among socio-economic classes. *Indian Psychological Review*, 1977, 14 (4), 5-15.

Kapur, I. N. Measuring and encouraging creativity in mathematics. *Creativity Newsletter*, 1-9.

Kelley, G R Creativity, school attitude and intelligence relationships in grades four, six and eight. *Dissertation Absiracts*, 1965, 25 (11), 6390

Kendall, M. G. *Rank correlation methods*. London. Griffin 1948.

Khatena, J Creativity : concept and challenge. *Educational Trends* 1973, 8 (1-4), 7-18.

Kimball, J. W. *Biology*. New Delhi : Oxford & IBH Publishing Co., 1978, 831

Kleinfeld, J. S Classroom climate and the verbal participation of India and Eskimo students in integrated classrooms *Journal of Educational Research*, 1973, 67 (2), 51-52

Kneller, G. F *The art and science of creativity.* New York : Holt, Rinehart and Winston, 1965

Koestler, A The sleepwalkers A history of man's changing view of the universe. London : Hutchinson, 1959.

Koestler, A. *The act of creation.* NYC Dell, 1964, Cited by Olmo, B G in 'Retroduction : The key to creativity.' *Journal of Creative Behavior,* 1977, 11 (3), 216-221.

Kravetz, N. The creative child in the uncreative school. *Educational Forum,* 1970, 34, (2), 219-222.

Kris, E *Psychoanalytic explorations in art.* New York · International Universities Press, 1952.

Lancaster, O E *Effective teaching and learning* London · Gordon and Breach 1974

Langdon, E ; Longstreth, B D. ; Linda, C. , Debbi, F , Jeffrey, O. , Marie, and Taylor, E. *Developmental Psychology,* 1981, 17 (5), 532-541

Lawrenz, F P and Welch, W. W. Student perceptions of science classes taught by males and females. *Journal of Research in Science Teaching,* 1983, 20 (7), 655-662.

Lawson, A and Ingleby, J D Daily routines of preschool children : Effects of age, birth order, sex and social class and developmental correlates. *Psychological Medicine,* 1974 (4), 399-415 In *Psychological Abstracts,* 1975, 54 (2), 335 (2711).

Leeper S H. ; Dales, R J. ; Skipper, D S and Witherspoon, R. L. *Good schools for young children.* London : Macmillan, 1968, 62

Lehois G An analysis and synthesis of the concept of creativity. *Dissertation Abstracts,* 1963, 24, 1883

Lipathy. T ; Held, L and Hrnciar, P. K uplatnovaniu poznatkov psychologie tvorivostipri vyucovani chemie/on the application of knowledge of psycology of creativity in teaching chemistry. *Jednotna Skola* 1983, 35 (1), 51-61. In *Psychological Abstracts,* 1984, 71 (4), 113.

Littlejohn, M. T Creativity and masculinity and faminmity in ninth graders *Perceptual and Motor Skills,* 1967, 25, 737-743.

Lorr, M and Jenkins, R. L. Three factors in parent behaviour. *Journal of Consulting Psychology,* 1953, 17, 306-308.

Lowenfeld, V *Creative and mental growth* New York : The Macmillan Co. 1958.

Lowenfeld, V and Beittel, K. Interdisciplinary criteria of creativity in the Arts and Sciences ; A progress report Research Yearbook Kutztown, Penn The National Art Education Association, 1959, 35-44.

Lowenfeld, V and Brittain, L. *Creative and mental growth.* New York : Macmillan, 1970, 6

Lytton, H and Cotton, A C. Divergent thinking abilities in secondary schools. *British Journal of Educational Psychology,* 1969, 39, 188-190.

Maccoby, E E. and Gibbs, P K. Methods of childrearing in two social classes In Martin, W E. and Stendler, C. E. (Eds). *Readings in Child Development.* New York : Harcourt Brace, 1954.

Mac Gregor, M. and Smith, J. L. Originality and role perception in elementary and junior high school children. *Dissertation Abstracts*, 1965, 25 (11) 6762.

MacKinnon, D. W. What makes a person creative ? *Saturday Review*, 1962, 46, 6, 15-17.

MacKinnon, D W Personality and the realization of creative potential *American Psychologist*, 1965, 20, 273-281.

Majumdar, S K In search of a construct for scientific creativity. *Teacher Education*, 1973, 7 (4), 3-10

Majumdar, S K Scientific creativity-the latest fad ! *Vigyan Shikshak*, 1974, 18 (3), 28

Marjoribanks, K. Environment, social class and mental ability. *Journal of Educational Psychology*, 1972, 63, 103-109.

Maslow, A H *Towards a psychology of being.* Princeton, N. J · Van Nostrand, 1962

Maslow, A H A holistic approach to creativity In Tayler, C. W. (Ed) *Climate for creativity.* New York Pegamon Press, 1972.

McClelland, D C , Baldwin, A L ; Bronfenbrenner, U and Strodtbeck, F.L *Talent and society New perspectives in the identification of talent.* Princeton, N. J. Van Nostrand, 1958.

McCurdv, H G The childhood pattern of geniuses *Journal of the Elisha Mitchell Scientific Society*, 1957, 73, 448-462 In King, R A (Ed) *Readings for an introduction to psychology.* New York . McGraw Hill, 1961, 296-278.

McPherson, J M A proposal for establishing ultimate criteria for measuring creative output In Taylor, C. W. and Barron, F (Eds) *Scientific creativity Its recognition and development* New York : John Wiley & Sons, 1963, 24.

Melrose, B M The relationship between maternal and teacher child-rearing attitudes and teacher-child and child-teacher preferences. *Dissertation Abstract International*, 1975, 35 (7-A), 4256.

Mettal, W. G Cybernetics, general systems and creative problem-solving. *Journal of Creative Behavior*, 1977, 11 (1), 53

Meyer, W The identification and encouragement of mathematical creativity in the first grade students Ph D. Dissertation, University of Wisconsin, 1970 *Dissertation Abstract International*, 31-B, 809-810

Middents, G. J Relationship of creativity and anxiety. *Dissertation Abstracts*, 1968, 28 (7), 2562A.

Milgram, R and Milgram, N Group vs individual administration in the measurement of creative thinking in gifted and nongifted children. *Child Development*, 1976, 47, 563-565

Miller, D. R and Swanson, G E. The changing American parent A study in the detroit area. New York · Wiley, 1958, In Krech, D. , Cructchfield,

R. S. and Ballachey, E. L (Eds.) *Individual in Society*. Tokyo · Kogakusha Company, Ltd., 1962, 373-374.

Misra, K. S. Creative teaching of Biology *Creativity Newsletter*, 1978, 7 (1), 33-39.

Misra, K. S. Anticreativity climate. *Creativity Newsletter*, 1978-79, 7-8 (2,1), 41-43.

Misra, K S A study of scientific creativity of boys in two institutional settings. *Experiments in Education*, 1980, 7 (12), 223-224.

Mitra, I Creativity : Some research findings. In Proceedings of a seminar on *'Creativity and undergraduate science education'*. held at the Department of Physics, Aligarh Muslim University, Aligarh, 1972.

Moore, O K Orthographic symbols and the preschool child. Proceedings of the third Minnesota Conference on Gifted Children. Minneapolis, 1960, 91-101.

Moore, S. G and Bulbulian, K. N. The effects of contrasting styles of adult-child interaction on children's curiosity. *Developmental Psychology*, 1976, 12 (2), 171-172.

Moos, R. *Evaluating treatment environment : A social ecological approach* New York . John Wiley and Sons, 1974.

Moos, R. H and Trickett, E J. Classroom environment scale manual Paulo Alto Consulting Psychologist Press, 1974 Quoted by Nielson, D H and Moos, R H in Exploration and adjustment in high school classrooms A study of person-environment fit. *Journal of Educational Research*, 1978, 72 (1), 52-57.

Musgrove, F. *The migratory elite.* Heinemann, 1963.

Neufeld, J J. The relationship of creative thinking abilities to the academic achievement of adolescents. *Dissertation Abstracts*, 1964, 25, 3404.

Newell, A , Shaw, J. C. and Simon, H A. The process of creative thinking, In Gruber, H E ; Terrell, G. and Werthermer (Eds) *Contemporary approaches to creative thinking*. New York · Atherton, 1962.

Nicholls, J, G. Creativity in the person who will never produce anything original and useful : The concept of creativity as a normally distributed trait *American Psychologist*, 1972, 27, 717-727.

Nichols, R C Parental attitudes of mothers of intelligent adolescents and creativity in their children *Child Development*, 1964, 35, 1041-1050.

Nijhawan, H K *Anxiety in school children.* New Delhi : Wiley Eastern Private Ltd., 1972.

Nuttal, E V. Creativity in boys A study of the influence of social back-ground, educational achievement and parental attitudes on the creative behaviour of ten year old boys. *Dissertation Abstract International*, 1970, 31 (IA), 213.

Ogletree, E J. A cross-cultural exploratory study of the creativeness of Steiner and state school pupils in England, Scotland and Germany. *Dissertation Abstracts*, 1968, 29 (2), 516A.

Olson, D. R. *Cognitive development The child's acquisition of diagonality.* New York : Academic Press, 1970.

Orienstein., A. S. An investigation of parental childrearing attitudes and creativity in children. Unpublished doctoral dissertation. University of Denver, Denver, Colorado, 1961.

Paramesh, C. R. *Creativity and personality.* Madras : Janatha Book House, 1972.

Peikin H. V Climate influences group learning. *Journal of Educational Research,* 1951, 45, 115-119, 348.

Pfeiffer, R S. The scientific concept of creativity *Educational Theory,* 1979, 29 (2), 129-136

Piaget, J. *Six psychological studies* New York . Random House, 1967.

Piaget, J. *The moral judgment of the Child* New York : Macmillan, 1955 In Naier, H W. (Ed) *Three theories of child development.* Tokyo . John Weatherhill, Inc 1969, 100.

Piaget, J Piaget's theory. In Mussen, P H (Ed) *Carmichael's Manual of Child Psychology.* New York : Wiley, 1970, 703-732.

Piaget. J The theory of stages in cognitive development. In Green, D. ; Ford, M. and Flamer, G (Eds) *Measurement and Piaget.* New York · McGraw Hill, 1971, 1—11.

Pine, F. Thematic drive content and creativity. *Journal of Personality,* 1959, 27, 136-151.

Plowmann, P. D. Futuristic images of education : Images of what might be *Journal of Creative Behavior,* 12 (2), 1978, 90-97.

Poincare, H. *The foundations of science.* New York . Science Press, 1913.

Popper, K. R. *The logic of scientific discovery.* New York : Basic Books, 1959.

Porter, B. Measurement of parental acceptance of children. *Journal of Home Economics,* 1954, 46, 176-182

Powell, J. , Martindale, A. and Kulp, S. An evaluation of time capsule measures of behaviour, *Journal of Applied Behaviour Analysis,* 1975, 8,463-469. Cited by Harrap, L A in 'Unreliability of classroom observation'. *Educational Research,* 1979, 21 (3), 207-211.

Prakash, A. O Understanding the fourth grade slump . A study of the creative thinking abilities of Indian children Master dissertation, University of Minnesota, 1966.

Prouse, H L. The construction and use of a test for the measurement of certain aspects of creativity in seventh grade mathematics. Ph D. Dissertation, University of Iowa, 1964.

Pullan, J. M Informal schools in Britain today-towards informality. NYC : Citation Press, 1971.

Pulsiver, S. N. *Children are poets.* Cambridge, M.A. : Dresser, Chapman & Grimes, 1963.

Puranjoti, T A study of the relationship between the verbal interaction of elementary science teachers with their students' creativity *Dissertation Abstracts*, 1972, 33, 633A

Rabinowitz, W. and Rosenbaum, I A failure in the prediction of pupil-teacher rapport. *Journal of Educational Psychology*, 1958, 49 (2), 93-98.

Radin, N. Maternal warmth, achievement motivation and cognitive functioning in lower class preschool children *Child Development*, 1971, 42, 1560-1565.

Radke, M. J *The relation of parental authority to children's behaviour and attitudes* Minneapolis : University of Minnesota Press, 1946.

Raina, M K. A study of some correlates of creativity in Indian students Doctoral dissertation, University of Rajasthan, 1968.

Raina, M K Sex differences in creativity in India *Journal of Creative Behavior*, 1963, 3, 111-114

Raina, M K Creativity research in cross-cultural perspective Unpublished paper. Meerut Meerut University, 1-32

Raina, T. N. About the issue · Editorial. *Educational Trend*, 1973, 8 (1-4), *i*

Raina, T. N. Sex differences in creativity in India : A second look. *Indian Educational Review*, 1982, 17 (3), 122-128

Randhawa, B. S. and Fu, L.L W Assessment and effect of some classroom environmental variables. *Review of Educational Research*, 1979, 43 (3), 303-321.

Rao, T. V ; Reddy, N. Y and Chattopadhyay, S N Conceptualizing and measuring organizational climate of a small industry A psychological probe. *Research Bulletin*, 1969, 5, 29-34.

Rapaport, D, *Organization and pathology of thought*. New York · Columbia University Press, 1951.

Rathbone, C. (Ed) Open education The informal classroom. NYC . Citation Press, 1971.

Razik, T M A An investigation of creative thinking among college students *Dissertation Abstracts*, 1964, 24 (7), 2775
Read, K H Parent's expressed attitudes and children's behaviour. *Journal of Consulting Psychology*, 1945, 9, 55-100

Read, K H. Parent's expressed attitudes and children's behavioru *Journal of Consulting Psychology*, 1945, 9, 55-100.

Rhodes, M An analysis of creativity. *Phi Delta Kappan*, 1961, 42, 305-310

Rejai, M On the failure of parents in the educational process. *Educational Forum*, 1979, XLIII, 4, 435-437.

Remmers, R. H Rating methods in research on teaching. In N. L. Gage (Ed.) *Handbook on Research on Teaching*. Chicago : Rand McNally, 1963.

Rodrigues, C. J. and Soriano de Alencar, E. M. Um estodo do pensamento criativo em alunos de 1 ° grau [A study of the creative thought of middle

school students]. *Arquivos Brasileiros de Psicologia,* 1983, 35 (1), 113-122. In *Psychological Abstracts,* 1983, 71 (8), 2119

Roe, A. Crucial life experiences in the development of scientists. In Torrance E P. (Ed) *Talent and education.* Minneapolis, Minnesota University of Minaesota Press, 1960, 66-77.

Roe, A and Siegelman, M. A parent-child relations questionnaire *Child Development,* 1963, 34, 355-369.

Roff, M A factorial study of the Fels Parent Behavior Scales. *Child Development,* 1949, 20, 29-45

Rogers, D *Child psychology.* California, Belmont · Brooks Cole Publishing Campany, 1969, 159.

Rosen, B and D' Andrade, R The psychological origins of achievement motivation *Sociometry,* 1959, 22, 185-218.

Rusch, R R , Denny, D A and Ives, S The development of a test of creativity in the dramatic arts A pilot study. *Journal of Educational Research,* 1974, 57 (5).

Russel, D. H. Higher mental processes. In Harris, C W. (Ed.) *Encyclopedia of Educational Research* New York Macmillan Company, 1960 645-657.

Sadker, D. Dimensions of the elementary school environment : A factor analytic study *Journal of Educational Research,* 1973, 66 (10), 441-442.

Sagar, C J. and Kaplan, H S. *Progress in group and family therapy.* New York : Brunner Mazel, 1972.

Sandler, B. E. ; Taylor, I. A. and Dorn, R. C. A creative leadership development program for college administrators. *Journal of Creative Behavior,* 1977, 11 (2), 124-130.

Schaefer, E S. and Bell, R Q. Development of the parental attitude research instrument. *Child Development,* 1958, 29, 339-361

Scheck, D C and Emerick, R. The young male adolescent's perception of early child-rearing behaviour · The differential effects of socio-economic status and family size. *Sociometry,* 1976, 39 (1), 39-52. In *Psychological Abstracts,* 1976, 56 (1), 73 (587).

Schecter, D. E. Notes on the development of creativity. *Contemporary Psychoanalysis,* 1983, 19 (2), 193-199. In *Psychological Abstracts,* 1984, 71 (1), 685.

Schempp, P. G. ; Cheffers, J. T. and Zaichkowsky, L. D. Influence of decision making on attitudes, creativity, motor skills and self concept in elementary children *Research Quarterly for Exercise & Sport,* 1983, 54 (2). In *Psychological Abstracts,* 1984, 71 (1).

Sears, R. R. ; Maccoby, E. E. and Levin, H *Patterns of child-rearing.* Evanston, Ill. . Row Peterson, 1957.

Segal, H Art and the inner world. *Times Literary Supplement,* 1975 (July, 18), 800 801

Serot, N. and Teevan, R C. Perception of the parent child relationship and its relation to child adjustment *Child Development*, 1961, 32 (2), 373-378.

Shapiro, R. J The criterion problem. In Vernon, P. E. (Ed.) *Creativity*. Harmondsworth . Penguin Books, 1972.

Sheck, D. C and Emerick, R. The young male adolescent's perception of early childrearing behaviour : The differential effects of socio-economic status and family size *Sociometry*, 1976, 39 (1), 39-52 In *Psychological Abstracts*, 1976, 56, (1), 73 (587).

Shmukler, D. Early home background features in relation to imaginative and creative expression in third grade *Imagination, Cognition and Personality*, 1982-83, 2 (4), 311-321 In *Psychological Abstracts*, 1984, 71 (6), 1543.

Shoben, F J The assessment of parental attitudes in relation to child adjustment *Genetic Psychology Monograph*, 1948, 39, 101-148

Shukla, J. K and Raina, M K. Cognitive measures of creative thinking ability In Ahmed, R. (Ed.) *Creativity and undergraduate science education* Proceedings of a seminar held at Department of Physics, Aligarh Muslim University, Aligarh, 1972.

Sidana, U R. and Sinha, D. Child rearing practices and the development of fears in children *Indian Journal of Psychology*, 1973, 48 (2), 34-48.

Siegel, S. *Nonparametric statistics for the behavioral sciences*. Kogakusha : McGraw Hill, 1956.

Silbergeld, S , Koenig, C R and Manderscheid, R W. classroom psychosocial environment *Journal of Educational Research*, 1975, 69 (4), 151-155

Silverberg, R A. The relationship of children's perceptions of parental behaviour to the creativity of their children. *Dissertation Abstract International*, 1970, 31 (12-A)

Sinnott, E W ; Dunn, L C and Dobzhansky. *Principles of genetics*. New Delhi Tata McGraw Hill Publishing Co , T. 1976, 19.

Smith, L M. and Geoffrey, W *The Complexities of an urban classroom*. New York · Holt, Rinehart and Winston, 1968.

Smith, J and Torrance, E P. *Creative teaching of the creative arts*. Boston . Allyn & Bacon, 1967.

Snyder, B. Creative studies in science and engineering- *University Quarterly*, 1967, 21 (2), 42-48.

Solomon, A O. A comparative analysis of creative and intelligent behaviour of elementary school children with different socio-economic backgrounds. *Dissertation Abstracts*, 1968, 29 (5), 1457-A.

Sprecher, T B A proposal for identifying the meaning of creativity In Taylor, C W and Barron, F. (Eds,) *Scientific creativity Its recognition and development*. New York : John Wiley & Sons, 1963, 77-78.

Steele, J. M ; House, E R and Kerins, T An instrument for assessing instructional climate through low inference student judgment *American Educational Research Journal*, 1971, 8, 447-466.

Stein, M. I Creativity and culture *Journal of Psychology*, 1953, 36, 311-322.

Stein, M. I A transactional approach to creativity. In Taylor, C. W and Barron, F. (Eds) *Scientific creativity . Its recognition and development.* New York . John Wiley, 1963, 217-227.

Stoddard, 1959. Quoted by Raina, T. N. in 'Emergence of the originals' *Educational Trends*, 1973, 8 (1-4), 102.

Stogdill, R. M. Attitude of parents, students and mental hygienists towards children behaviour. *Journal of Social Psychology,* 1933, 4, 486-489.

Strauss, M. E and Strauss, M A. Family roles and sex differences in creativity of children in Bombay and Minneapolis *Journal of Marriage and Family*, 1968, 30 (1), 46-53.

Stringham, E. *Outline of patent law and guide to digests.* Madison, Wisc. : Pacot Publications, 1937, 227-245.

Symonds, P. M. *The psychology of parent-child relationship.* New York : Appleton Century Crofts, 1939

Taylor, C W *et al* The second (1957) University of Utah research conference on the identification of creative scientific talent. Salt lake city . University of Utah Press, 1958, 36-47

Taylor, C W. ; Smith, W R. and Ghiselin, B. The creative and other contributions of one sample of research scientists In Taylor, C. W. and Barron, F (Eds.) *Scientific crativity : Its recognition and development.* New York : John Wiley & Sons, 1963, 53-76.

Taylor, D W. Variables related to creativity and productivity among men in two research laboratories. In Taylor, C. W and Barrow, F. (Eds.) *Scientific creativity : Its recognition and development.* New York John Wiley & Sons, 1963, 228-250.

Terman, L. M The discovery and encouragement of exceptional talent. *American Psychologist,* 1945, 9, 221-230.

Thistlethwaite, D. L. College environments and the developments of talent *Science*, 1959, 50, 183-191.

Thomas, N. G. and Berk, L. E. Effects of school environments on the development of young children's creativity. *Child Development*, 1981, 52 (4), 1153-1162

Torrance, E. P. Explorations in creative thinking. *Education*, 1960, 81, 216-220.

Torrance, E P. *Education and the creative potential.* Minneapolis : The University of Minnesota Press, 1963

Torrance, E P. Toward the more humane education of gifted children. *Gifted Child Quarterly*, 1963, 7, 135-145.

Torrance, E. P. Scientific views of creativity and factors affecting its growth In Kagan, J (Ed.) *Creativity and learning.* Bostan : Houghton Mifflin, 1967, 73-74.

Torrance, E. P. *Guiding creative talent* New Delhi : Prentice Hall of India, 1969

Torrance, E P. and Myers, R. E. *Creative learning and teaching* New York · Mead and Company, 1970.

Torrance, E P Can we teach children to think creatively ? *Journal of Creative Behavior*, 1972, 16 (2).

Torrance, E. P. and Torrance, J P *Is creativity teachable* ? Bloomington, Ind Phi Delta Kappa Educational Foundation, 1976.

Torrance, E. P. and Hanson, E. The question asking behavior of highly creative and less creative basic teachers identified by a paper and pencil test. *Pychological Reports*, 1965, 17, 815-818.

Toynbee, A Is America neglecting her creative minority ? In Taylor, C W (Ed.) *Widening horizons in creativity* New York Wiley, 1964, 3-9

Traube, A. M Observations on creativity *Educational Forum*, 1972, 27 (1), 59-65.

Treffinger, D J , Renzulli, J S and Feldhusen, J. F Problems in the assessment of creative thinking. *Journal of Creative Behavior*, 1971. 5 (2), 104-112.

Triandis, H. , Bass, A. ; Ewen, R. and Mikesele, E Teaching creativity as function of the creativity of the members. *Journal of Applied Psychology*, 1963, 47, 104-110.

Tucker, B Z and Bernstein, A J Child, school, family An international view *Journal of Education*, 1979, 161 (2), 71-78

Tucker, B Z and Dyson, F The family and the school · Utilizing human resources to promote learning. *Family Process*, 1976, 15 (1), 125-141

Tyas, B *Child drama in action* NYC Drama Book Specialists, 1971.

Vaidya, N. How children discover knowledge ? New Delhi : Oxford & IBH, 1974

Vaidya, N *The impact science teaching*. New Delhi Oxford & IBH, 1977

Vaidya, N and Sukumaran, P N The face of creativity in school science *Educational Trends*, 1978, 13 (1), 63-70

Veroff, J. Social comparison and the development of achievement motivation. In Smith, C P (Ed) *Achievement related motives in children* New York Russel Sage Foundation, 1969.

Vinacke, W E *The psychology of thinking* New York : McGraw Hill Book Company, 1952, 262-286

Vygotsky, L S. *Thought and language* (Hanfman, E and Vakar, G trans) Cambridge M.I.T. Press, 1962, 47-57

Wade, S. E. Adolescents, creativity and media. *American Behavioural Scientist*, 1971, 14, 341-351

Walberg, H. J Social environment as a mediator of classroom learning. *Journal of Educational Psychology*, 1969, 60, 443-448

Walberg, H. J. Varieties of adolescent creativity and the high school environment *Exceptional Children*, 1971, 38, 111-116

Walberg, H J and Anderson, G J Properties of the achieving urban classes *Journal of Educational Psychology*, 1972, 63, 381-385.

Walker, W J Creativity and high school climate, in J. C. Gowan, et al (Eds) *Creativity Its educational implications*, 1967, 295-307

Wallach, M A. and Kogan, N Behavior in the school environment. In *Modes of thinking in young children*. Holt, Rinehart and Winston, 1965.

Watson, G Some personality differences in children related to strict or permissive parental discipline *Journal of Psychology*, 1957, 44, 227-249

Watts, B. H. The home context. In Campbell, W. J (Ed) *Scholars in context*. Sydney John Wiley & Sons, 1970, 103

Weber, W A Relationship between teacher behaviour and pupil creativity. ERIC, 1968, 4, 8, 105.

Webster, M. A and Walker, M. B Divergent thinking in arts and science students : The effect of item content. *British Journal of Psychology*, 1981, 72, 331-338.

Wees, W R *Nobody can teach anyone anything* NYC Double Day, 1971.

Weininger, O. Some thoughts on creativity and the classroom *Journal of Creative Behavior*, 1977, 11 (2), 109-118.

Weisbender, L F A four year follow-up of educationally disadvantaged preschool children analyzing home environment variables facilitating achievement. *Dissertation Abstract International*, 1969, 30 (3-4A), 1442.

Weisberg, P S and Springer, K. J. Environmental factors in creative function : A study of gifted children *Archives of General Psychiatry*, 1961, 5, 554-564

Whiting, J. W. M. and Child, J. L. *Child training and personality*. New Haven . Yale University Press, 1953.

Williams, F E The search for the creative teacher. In Gowan, J. C ; Demos, G E. and Torrance, E. P (Eds) *Creativity : Its educational implications* New York John Wiley & Sons, Inc , 1967 , 279.

Wilner, M S The differential effects of assessment contexts on factors of divergent thinking abilities and creativity IQ relationships in sixth grade boys *Dissertation Abstract International*, 1975, 35 (11-B), 5655

Winterbottom, M. The relation of need for achievement in learning experience in independence and mastery In Atkinson, J (Ed) *Motives in fantasy action and society*. Princeton, N J : Van Nostrand, 1958, 453-478.

Withall, J Problem behaviour Function of socio-emotional climate. *Journal of Education*, 1979, 161 (2), 89-101

Wolf, A The dynamics of the selective inhibition of specific functions in neurosis *Psychol. Med*, 1943, 5, 27-38.

Wolf, D America's resources of specialized talent New York · Harper, 1954.

Wolf, R The measurement of environment In Anastasi, A. (Ed) *Testing problems in perspective* Washington, D. C. American Council on Education, 1966

Wood, D *Test construction* Columbas, Ohio : Charles E. Merrill, 1960, 96

Wright, H. F. Reading and analyzing child behaviour : With ecological data from an American town New York : Harper & Row Publishers, 1967. In Buros, O K. (Ed) *The seventh mental measurements yearbook.* New Jersey, Highland Park The Gryphon Press, 1972, 2, 839-840

Yarrow, L and Goodwin, M Some conceptual issues in the study of mother infant interaction *American Journal of Orthopsychiatry*, 1965, 35, 473-481 Quoted by Johnson, R. C. and Medinnus, G R. *Child Psychology : Behaviour and Development*, 1969, 312.

Yamamoto, K. Further analysis of ask and guess tests (Research Memorandum BER-6011) Minneapolis : Minnesota Bureau of Educational Research, University of Minnesota, 1960

Yamamoto, K. Creative thinking : Some thoughts on Research. *Exceptional Children*, 1964, 30, 403-410

Yonng, M and McGeeney, P *Learning begins at home.* London · Routlege & Kegan Paul, 1968, 6